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J. A. HOLMES,
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JOURNAL

OF THE

ELISHA MITCHELL SCIENTIFIC SOCIETY.

REPORT OF THE RESIDENT VICE-PRESIDENT FOR THE YEAR 1886–'87.

J. A. HOLMES.

The Society has now completed the fourth year of its existence. And the result of its work during the past year, and of the three years preceding, afford the assurance that it may be now regarded as a permanent institution. Kind words of encouragement have come in from eminent sources; applications for the Journals of the Society have increased in number; the society has now on its exchange list Journals of many of the more prominent societies of the United States, and of several foreign societies; and there has been a steady improvement in the extent and character of the original investigations being carried on by members of the Society.

It is worthy of mention, too, that the system of public lectures which was inaugurated at the State University by this Society has been adopted by other institutions in this and adjacent States. And the Secretary of this Society has been in correspondence with gentlemen connected with other Southern institutions who intend organizing similar Societies. We may believe, then, that this humble beginning made here less than four years ago, is doing something to awaken a new activity in scientific work not only in our own State but also in other Southern States.

The following summary will exhibit in a general way the

work of the Society during the past four years of its existence:

	1883–'84	'84–'85	'85–'86	'86–'87	Totals
Meetings, ...	6	5	8	9	28
Public Lectures,.....	—	4	—	3	7
Papers presented.....	67	43	60	53	223
Papers published.....	98	100	148	150*	500

The above table shows a decrease in the number of papers presented; but there has been a decided improvement in the length and value of the papers, that has more than counterbalanced the falling off in number. The Journal for 1886 and 1887, which is to be published in two parts, will probably contain more papers than is indicated above. A detailed statement would show more clearly the growth of the Society; but this can not be given here.

But while the Society is making real advancement it is doing so under disadvantages. Its membership has not been increased as was hoped it would. The students and graduates of the University and other institutions have not associated themselves with it, nor have taken part in its work as it was expected they might, and as it is hoped they will do in the future. Nor has the Society received the liberal financial support which it needs to increase the publication of its Journals. The Society needs in every way a more generous support; and for this it must appeal to its members and all others interested in scientific work in the State.

Among the present and pressing needs of the Society I may mention the following:

(1) The hearty co-operation of a much larger number of persons in the State engaged in, or interested in, scientific work. All such should become members of the Society and co-operate with it in its work.

(2) A more liberal financial support. During the past year for want of funds the Society was unable to publish several papers presented for publication in the Journal. Among the members of other Societies are often to be found men of wealth and liberality who contribute largely to the financial support of the Societies to which they belong, and have won the title of "patrons' of the Society. A few members of the Mitchell Society have contributed liberally to its

*Number of pages estimated—not yet published.

financial support during the past year; and it is earnestly hoped that this membership will increase.

(3) Contributions to the Library of the Society. During the past few months an encouraging beginning has been made in this direction, and it is hoped that much more will be accomplished during the coming year. The Society desires to collect together for preservation and reference, all books, pamphlets, manuscripts, maps, &c., that have any bearing upon the history, natural history, or resources of North Carolina, and any books, pamphlets, maps, &c., written by members of the Society, or workers in North Carolina. Already there has been collected together upwards of 400 such books, pamphlets and journals of other Societies.

A system of public lectures was organized again during this year, and three lectures have been given. These will be continued during the next year under the direction of the council.

The Journal of the Society for 1885–'86, published during the past year, was a pamphlet of 148 pages. The Journal for 1886–'87 will be published in two parts of probably 75 pages each. Part I will be printed during the early summer. Part II will appear later in the year.

As a continuation of the series of biographical sketches Part I of the Journal will contain a short sketch of Prof. Marcellus Hentz. Part II will contain a sketch of the late Prof. W. C. Kerr.

The President of the Society, on account of ill health, has been unable to meet with the Society during the year; but in various ways he has given assistance and encouragement.

During the year one death has occurred among the Life Members of the Society: Right Rev. Wm. M. Green, Bishop of Mississippi, and one among the regular members, Col. J. B. Wheeler.

REPORT OF THE SECRETARY.

F. P. VENABLE.

BUSINESS MEETINGS.

AUGUST 28, 1886.

Prof. Holmes in the chair. The date of the public meetings was changed to the second Tuesday in each month. The condition of the Treasury was discussed and the Treasurer was directed to advertise and place on sale the new Journals.

OCTOBER 15, 1886.

Prof. Holmes presided. It was directed that papers presented before the Society be, as far as possible, on uniform paper, as to size at least, and that the Publication Committee take charge of the papers immediately after each meeting, deciding which are to be published and which placed on file, finally placing them in the hands of the Secretary.

Arrangements were directed to be made for storing the books and pamphlets belonging to the Society where they would be convenient for reference.

A Committee was appointed to take steps towards effecting an interchange of publications with other bodies having a like aim with this Society.

MAY 7, 1887.

Prof. Holmes in the chair. The Secretary and Treasurer presented his reports.

It was ordered that the monthly bulletins containing abstracts of papers read at the public meetings be issued also during the coming year.

In view of this increase of the Secretary's duties and of the rapidly growing library of the Society the office of Recording Secretary and Librarian was created.

By a vote of the Society the office of Corresponding Secretary was made permanent.

To insure more rapid publication of the material on hand it was decided that hereafter the Journal be published in two semi-annual parts.

The following officers for 1887–1888 were then elected:

PRESIDENT—Dr. R. H. Lewis, Raleigh, N C.

VICE-PRESIDENTS—Prof. W. L Poteat, Wake Forest College, and Dr. W. B. Phillips, Chapel Hill.

SECRETARY AND TREASURER—Dr. F. P. Venable, Chapel Hill.

RECORDING SECRETARY—Prof. J. W. Gore, Chapel Hill.

PUBLICATION COMMITTEE—Profs. Graves, Holmes and Love, Chapel Hill.

As Honorary members the following were elected:

Major J. W. Powell, U. S. Geological Survey; Hon. S. F. Baird, Smithsonian Institution, and Dr. C. V. Riley, Department of Agriculture.

As Corresponding members:

Prof. E. E. Smith, University of Alabama; Dr. D. Day, U. S. Geological Survey; Dr. J. M. McBryde, University of South Carolina, and Prof. W. J. McGee, U. S. Geological Survey.

A number of regular members were also elected, a list of whom will appear in the second part of the Journal.

PUBLIC MEETINGS.

NATURAL HISTORY LECTURE ROOM,

XX. PUBLIC MEETING. *September* 14, 1886.

1. Examination of certain North Carolina Clays,.....W. B. Phillips.
2. Treatment of Refractory Phosphates,.....W. B. Phillips.
3. Report on the last meeting of American Association for the Advancement of Science,.....J. W. Gore.
4. Report on recently Discovered Elements,.....F. P Venable.
5. Report on Saccharine,.....F. P. Venable.
6. New Instances of Protective Resemblance in Insects, G. F Atkinson.
7. Report on a Recent Discovery in Biology,.....G. F. Atkinson.

XXI. PUBLIC MEETING. *November*, 1886.

8. On the Parameter of a Plane,.....R. H. Graves and W. B. Phillips.

9. Report on Arsenic as a Poison,.....F. P. Venable.
10. A New Glow Worm,.....G. F. Atkinson.
11. A singular occurrence of Cerusite,.....W. B. Phillips.
12. Report on Earthquakes occurring at Charleston, from 18th Century to present time,.....J. A. Holmes.

XXII PUBLIC MEETING. *November*, 1886.

13 On Universal or Cosmic Time,.....J. L. Love.
14 A New Lamp for Laboratory Use,.....F. P. Venable.
15. A List of Minerals containing Phosphoric Acid.....W. B Phillips.
16. Subsidence along the Coast of New Jersey.....J. A Holmes.
17. Report on the Recession of Niagara Falls.....J. A. Holmes.

XXI PUBLIC MEETING. *December*, 1886.

18. Solar Eclipses.....J. W. Gore.
19. External Signs of Lodes and Veins,.....W B. Phillips.
20. Report on the Isolation of Fluorine,.....F P Venable.
21. Ancient Mathematics,.....R H. Graves.

XXIV PUBLIC MEETING. *January 25th*, 1887.

22. Report on Isolation of Fluorine, (continued),.....F. P. Venable.
23. Utilization of Wool Grease,.....F. P. Venable.
24. Can an Air-bubble Function as an Organ of Respiration,.....G. F. Atkinson.
25. Classification of Ore Deposits,.....W. B. Phillips.
26. Rainfall Statistics for North Carolina,.....J. A. Holmes.

XXV PUBLIC MEETING. *February 8th*, 1887.

27. The True Source of the Mississippi,.....J. W Gore.
28. Nomenclature of Lodes, Beds and Veins,.....W. B. Phillips.
29. A New Insec Epidemic,.....G. F. Atkinson.
30. Report on Carbon Dioxide in the Air,.....F. P. Venable.

XXVI PUBLIC MEETING. *March 8th*, 1887.

31. Sepulchral and Perpetual Lamps,.....Dr. H. C Bolton.
32. A New Test for Iron,.....F. P. Venable.
33. A Madstone,.....W B. Phillips.
34 Reversion of Superphosphates when Bottled,.....W. B. Phillips.
35. Temperature Statistics for North Carolina,.....J. A. Holmes.

XXVII PUBLIC MEETING. *April 12th*, 1887.

36. A Sarcoptid Mite,.....G. F. Atkinson.
37. The New Glow Worm,.....G. F. Atkinson.
38. Flowering of Plants in Chapel Hill section,.....L. W. Lynch.
39. Eine Verschiebung,.....W. B. Phillips.

40. Harnett County Fire Clay, ...W. B. Phillips.
41. Report on the Evaporation of Water on Stoves,.....F. P. Venable.
42. Report on the "Genesis of the Elements,".....F. P. Venable.
43. Average Elevation and Rainfall of North Carolina,...J. A. Holmes.

XXVIII PUBLIC MEETING. *May 10th*, 1887.

44. Hetero-somatism, ...W B Phi lps
45. Meteorology of Chapel Hill,..... ...J. W Gore.
46. Pr liminary List of Butterflies of Chapel Hill,.....A. Braswell.
47. Notes on Protective Resemblance in Butterflies,.....F. M. Harper.
48 Notes on Apple Blight,.....G. F. Atkinson.
49 Prelimi ary Li t of the Birds of Chapel Hill,.....G F. Atkinson.
50 Action of Chl rine Monoxide on Hexylen,.....R. G. Gris om.
51. Acti n of Halogen Acids on Lead, Arsenate and Phosphates,..... ... H. F. Shaffner.
52 Some New Lead Salts,..... .....F. P. Venable.
53 Repor s of Officers for 1886–1887.

PUBLIC LECTURES.

V—March 1, 1887.

The R sicrucians,.....F. P. Venable.

VI—March 22, 1887.

A Sketch of Mathematical and Physical Sciences from Aristarchus to Hipparchus,.....R. H. Graves.

VII—April 26, 1887.

Galilei, ...J. W. Gore.

TREASURER'S REPORT.

F. P. VENABLE.

Balance from October 1886	$ 85 57	
Additional fees for 1886	25 00	
Additional Journals sold	84 40	
Special contributions	85 00	
Fees collected for 1887	72 00	
Printing of Journal		$ 231 85
Postage		21 92
Stationery		4 50
Advertising		1 55
Plates		22 50
Freight and Expenses		2 60
Total amount received	351 97	
Total amount expended		284 92
Balance on hand May 15th	67 05	
Amount due from members	56 00	
Estimated sales of Journals	60 00	
Estimated expenses		250 00

It is evident from the above table that the estimated expenses run considerably beyond the probable income, and yet these expenses are placed at a much lower figure than for last year. It is therefore essential that special contributions reach the society's treasury in order that the work be maintained as heretofore.

A SKETCH AND BIOGRAPHY OF NICHOLAS MARCELLUS HENTZ.

N. M. HENTZ was born in Versailles, July 25, 1797. To this place his father, who was active in political affairs, had been obliged to flee from Paris, and conceal himself under an assumed name (Arnold). His son showed a remarkable talent for miniature painting while quite young, and attained considerable proficiency in this art. In 1813 he entered the Hospital Val de Grace as a student in medicine, where he remained busied with his studies and duties as hospital assistant until the fall of Napoleon. At this time his father was proscribed and obliged to flee to America.

The family, after their arrival in this country, spent a few weeks in New York City and Elizabeth Town, when they removed to Wilkesburg, Pa., the latter part of April, 1816.

For some years Hentz was engaged in Philadelphia and Boston as teacher of French and miniature drawing. Following this, for a short time he was tutor in the family of a weathy planter (Mr. Marshall) on Sullivan's Island, near Charleston, S. C.

While engaged as a teacher in a school for boys at Round Hill, Northampton, Mass., he was married to Miss Caroline Lee Whiting, the daughter of Gen. John Whiting, of Lancaster. His wife afterwards became well known as a poet and novelist.

Soon after his marriage, in 1824, he moved to Chapel Hill, N. C., where he had charge of Modern Languages in the State University until 1830. From this time up to 1849, he was in charge of various female seminaries and academies in the South; at Covington, Ky., Cincinnati, O., Florence, Tuscaloosa, and Tuskegee, Ala., and Columbus, Ga. His health having failed, he moved to the residence of his son Charles, at Mariana, Florida; where he died Nov. 4, 1856.

It is a remarkable fact that during his long life as a teacher he was one of the pioneers in American Entomology, and became during his time the highest authority on American Spiders. His life and work then are of special interest to the members of the Mitchell Society because of his connection with the University of North Carolina. All of his leis-

ure hours, during his life as a teacher, were devoted to these studies.

He was an intimate friend and co-worker with the well known entomologist, Harris, as the publications of the Boston Society of Natural History will testify.

He was very fortunate in selecting the spiders as his special field of study, for little or nothing at that time had been published on North American Spiders. His time was given to the observation of their habits, and to the collection, description and representation of the various species. He published a few papers in Silliman's Journal, and in the Journal of the Philadelphia Academy of Arts and Sciences, and then brought together his extensive series of notes and paintings, and offered them to the Boston Society of Natural History for publication in its Journal. The publication of these extended over a number of years. A few years ago, as many of the publications were out of print, the Council of the Society determined to republish, in a connected form, all of Hentz's arachnological writings. When this was done, a considerable number of notes and descriptions were added by Mr. J. H. Emerton, who has paid much attention to our native spiders. A few notes were also added by Mr. Wm. E. Holden of Marietta, O.

After Hentz's death, his collection of spiders went into the hands of the Boston Society, but has since been nearly destroyed.* G. F. ATKINSON.

LIST OF THE WRITINGS OF PROF. HENTZ.

1821. A notice concerning the spider whose web is used in medicine (*Tegenaria medicinalis*) Jour. Phil. Acad. Nat. Sci., II., p 53–55.

1825. Some observations on the Anatomy and Physiology of the Alligator of North America. Trans. Am. Phil. Soc., II., pp. 216–228.

1825. Description of some new species of North American Insects. Jour. Phil. Acad. Nat. Sci , V. pp 373–375.

1829. The same paper in Ferusac's Bulletin des Sciences Naturelles, XVIII., pp 475–476.

1830 Description of eleven new species of North American Insects. Trans. Amer. Soc., III., pp. 253–258.

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*The Spiders of the United States by Nicholas Marcellus Hentz, M. D. Occasional Papers of the Boston Society of Natural History, II, Preface

1830. Remarks on the use of the Maxillae in Coleopterous insects, with an account of two species of the family Telophoridae (*Chauliognathus marginatus*, and *C. bimaculas*), and three of the family Mordellidae (*R. hipiphorus dimidiatus*, *R. timbatus* and *R. tristis*) which ought to be the type of two distinct genera. *Ibid.* pp. 458–463.

1832. On North American Spiders. Silliman's Journal of Science and Arts. XXI., pp. 99–152.

1833. Enumeration of the Spiders of the United States. Hitchcock's Report on Geology, etc., of Massachusetts. p. 564, (contains only the list of genera published in the preceding paper).

1835. List of Spiders of the United States. *Ibid.* Second edition. (This edition enumerates one hundred and twenty-five species, mostly by name, and arranged under the genera given in the first edition. The species are those described in the Journal Bost. Soc. Nat. Hist.)

1841. Description of an American Spider (*Spermophora meridionalis*) constituting a new subgenus of the tribe Inæquitalæ, Latreille. *Ibid.* XLI. pp. 115–117.

1841. Species of Mygale of the United States. Proc. Bost. Soc. Nat. Hist., I. pp 41–42.

1842. Description and Figures of the Araneides of the United States. Journal Bost. Soc. Nist., IV., pp. 55–57. Pl. 7. Continuation, pp. 223–231. Pl 8.

1844. Continuation, ibid., pp. 386–396. Pl. 17–19.

1845 Continuation, ibid , V., pp. 189–202. Pl. 16, 17.

1846. Continuation, ibid , pp. 352–369. Pl. 21, 22

1847 Continuation, ibid., pp. 444–478. Pl. 23, 24, 30, 31.

1850. Continuation, ibid , VI., pp. 18–35. Pl. 3, 4. Conclusion, pp. 271–295. Pl. 9. 10.

1867. Supplement to the Description and Figures of the Araneides of the United States. Edited by S. H. Scudder. Proc. Bost. Soc. Nat. Hist., XI, pp. 103–111, with two plates.

NOTE.—This list is taken from "Occasional Papers of the Bost Soc. Nat. Hist, II. The Spiders of the United States by N M. Hentz, M. D. G. F. ATKINSON.

A NEW TRAP-DOOR SPIDER.

BY GEORGE F. ATKINSON.

In his excellent work on trap-door spiders, Mr. Moggride says, "There would doubtless be a just feeling of pride and satisfaction in the heart of a naturalist, who could say that he had made himself thoroughly acquainted with all the species of a particular group of animals, had learned their most secret habits, and mastered their several relations to the objects, animate and inanimate, which surrounded them. But perhaps a still keener pleasure is enjoyed by one who carries about with him some problem of the kind but partially solved; and who, holding in his hand the clue which shall guide him onwards sees in each new place that he visits fresh opportunities of discovery. The latter is certainly the condition of those who take an interest in searching out the habits and characters of trap-door spiders."[1]

While many interesting facts, in the life history, and architecture of trap-door spiders were observed and collected by Mr. Moggridge, he very modestly says that many remain yet to be gathered in; that we are only on the threshold of discoveries of these creatures who have lain quiet in the earth century after century; and that he will be satisfied to have been able to "hold the door sufficiently ajar to permit those who love nature and her ways to catch a glimpse of the wonders and beauties of the untrodden land that lies beyond."[2]

A favorable circumstance afforded me an opportunity for making some observations on the unseen "wonders and beauties of the untrodden land" which is the abode of these interesting creatures, and it is with a sense of pleasure that I note them.

Some time the latter part of May, or early part of June,

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[1]Harvesting Ants and Trap-Door Spiders. Supplement, p. 180.

[2]Harvesting Ants and Trap-Door Spiders, p. 136.

1885, Mr. Merritt, of Pittsboro, N. C., brought to Chapel Hill, two trap-door spiders with their nests, and placed them in the care of Prof. Holmes, for the University of North Carolina. The nests with their occupants were placed in the ground for the summer. On Nov. 12, after a careful search Prof. Holmes was able to find only one, and this one with difficulty, as for some reason it had dug through the lower end of the tube and was hidden in the earth. Later I shall offer what seems to me may be an explanation of this. On the morning of the same day, the spider with its trap-door nest was placed in my keeping, which was the first intimation I had of the presence of such an agreeable neighbor.

At 4:30, p. m., I placed 3½ inches of earth in a glass jar 5 inches in diameter and 7 inches deep. Two thirds of the surface of the soil was then covered with moss. In this the spider was placed, and the jar and its contents taken to my room, that I might, if possible, observe the operation of digging the tube and making the trap-door.

The results were most gratifying. Just before going to supper, at dusk, I observed that the spider had not undertaken the work. Upon returning at 8:30, p. m., I found the task undertaken. The spider was resting in a hole about $20^{m.m.}$ deep by $22^{m.m.}$ in diameter, which she had excavated at one side of the jar. I placed the jar upon my study table, just beneath the light of a student lamp, so that while reading I could observe any movements made by my companion. The spider was resting in the hole with its legs partially folded, the anterior ones lying upon the edge of the excavation

After I had been quiet for some time the spider began to move cautiously, and turning about slowly, went head first into the hole, and dug from the bottom with her mandibles a pellet of earth about the size of a small pea. Then turning carefully around she placed it at the edge of the hole where she pushed it off with aid of her palpi, at the same time working her mandibles up and down. At first the spider seemed timid, and would cease operations upon the slightest movement on the part of myself. During the course of the evening three other persons who came to my room had the fortune to witness the operation of digging out the earth. The spider soon became bold, paid no attention to movements in the room, and permitted me to watch her very closely. Occasionally, by using both palpi at once, the dirt was flirted suddenly from the grasp of the mandibles

with such force as to strike against the opposite side of the jar. Had it not been for this obstruction the dirt must have been thrown three or four feet.

After depositing each load on the edge of the hole the spider would turn around again for another load, but before picking it up, she would project the posterior pair of spinnerets about 5$^{m.m.}$ from the abdomen, and carefully knead the viscid liquid upon and around the freshly placed pellet of earth, and over the edge for a distance of 4$^{m.m.}$ or 5 $^{m.m.}$, for the purpose of making the soil adhere and prevent its caving in. In Plate I, Fig. 4, the spider is shown in the act of removing a pellet of earth from her mandibles. In Fig. 5, is represented the application of the viscid liquid. The ends of the spinnerets are applied to the surface alternately, as shown in the illustration. The legs took no part in the application of the viscid liquid; nor did the liquid form a thread when the spinnerets were drawn from the surface, as I have since seen it when the spider was crawling about on the surface of the earth.[1]

At 11:30 o'clock, when the hole was about 4$^{m.m.}$ in depth, to my surprise and pleasure the spider began to make the "trap-door." Standing upon its fore feet and placing the spinnerets against the glass jar at the level of the edge of the hole, the spider covered the glass with the viscid liquid. Several pellets of earth were stuck to this, each time another portion of the viscid liquid being applied. After a depth of 5$^{m.m.}$ had been built up in this way, which was to answer as the hinge, the spider cut a sprig of the moss and cemented it to the hinge so that the end projected above it. Small sticks, particles of moss and earth were constantly placed upon the edge of the growing door. Each time the spider would come out of the hole for new material, retreat backward, and turn half way around so as to apply it to the door. Placing the load on the under side of the partial door, she would carefully move it up to the edge. Then placing the distal portion of the palpi and anterior pair of legs above, while the proximal portion of these limbs and the ends of the mandibles were on the under side of the pellet and door, she would

[1] As I am now writing, Jan. 16, 1886, 11:55, p. m., the spider is crawling about on the surface of a freshly prepared jar of earth. Sometimes the viscid liquid adhering to some object is drawn out in a band of silk 2m.m. wide, and the pieces of moss strewn on the earth are loosely matted together in the path of the spider about the side of the jar.

fit and press it in shape, as one would mold with the hand a moist portion of earth by pressing it into a thin sheet. This is illustrated in Fig. 7, Plate XXII. Indeed it looked very much like the black bony fingers of a hand performing the work of pressing. The greatest pressure seemed to be brought to bear upon the rounded ends of the madibles. After fastening on a portion thus, the spider would take an inverted position and apply viscid liquid along the edge and under surface of the door, as shown in Plate XXIII, Fig. 6. She would then turn about and crawl out for more material. The hole being by the side of the jar, I could watch the operation both in the hole and upon the cover. By 1 o'clock in the morning (Nov. 13,) the door was finished so that the spider could pull down the lid, which completely closed the entrance, nicely fitting in around the edge and appearing as if there was no hole nor spider, but through the glass the spider could still be seen.

At intervals during the construction of the door, the spider would pull it down to observe where the next pellet should be placed in order to make the door fit the circular opening of the tube. Discovering this she would turn completely around, and not being able with her head in the bottom of the tube to see the place where she intended to put the next load, she would find it by feeling about with her spinnerets. The viscid liquid would then be applied and the pellet of earth fitted with extreme nicety. Satisfied with the result of my experiment I retired.

By daybreak I found that the excavation was continued after the completion of the trap-door, the soil being deposited around the nest to raise the surface of the earth in the jar to a level with the top of the nest. Without close searching it was impossible to detect the door.

The mode of making the trap-door by this spider differs very widely from that observed by other naturalists so far as I can find any record. Mr. Moggridge saw the female, *Nemesia Meriodinalis*, construct a trap-door in captivity. He made a cylindrical hole in a flower-pot of earth. Into this the spider disappeared. "During the night following the day of her capture she made a thin web over the aperture, into which she wove any material which came to hand. The trap-door at this stage resembled a rudely constructed, horizontal, geometrical web, attached by two or three threads to the earth at the mouth of the hole, while in this web were caught the bits of earth, roots, moss, leaves, etc., which the

spider had thrown into it from above. After the second night the door appeared nearly of the normal texture and thickness, but in no case would it open completely, and it seemed the spider was too much disgusted with her quarters to think it worth while to make a perfect door."[1]

He also records the making of a door by a very young one of this species, in which the threads, except at the hinge, were cut so that the door would open and shut.[2]

The only thing he records which seems at all analagous to the mode of making a trap-door exhibited by the spider in my possession is that manifested in the enlargement of nests and trap-doors by spiders as they grow larger, and consequently require nests of larger dimensions. This operation was not witnessed by him, however, but the additions to the size of the door were proven by measurements and observations upon nests of young spiders at different seasons.[3]

It would seem natural to suppose that, in making slight additions from time to time to the edge of the nest, the spider would cement pellets of earth, pieces of moss, etc., to the edge, instead of first spinning a web; unless the web is spun over the lower side of the door and made to project just far enough to fit the enlarged tube. In Plate XXIII, Fig. 8, can be seen eight concentric "lines of growth," as they might be termed, of the trap-door, corresponding to the growth and needs of the spider. These I judge to represent the successive enlargements of the door concomitant with the enlarging of the tube. We can safely say that these additions were made by cementing the material, piece by piece, which forms each ring, to the edge of the door. These "lines of growth" are not present in the door made by the adult spider in captivity. I induced the spider to make the door the fourth time, (Jan. 19, 1886,) in order to observe if there was any regularity in the cementing of the particles, which might form these lines of growth in a door made by an adult spider. There is no such regularity. Indeed his last door was made of about a dozen very large pellets of clay, which, being very plastic, the spider was able to press each pellet into a sheet of considerable dimensions.

It is to be regretted that Mr. Moggridge did not have the

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[1]Harvesting Ants and Trap-Door Spiders, p. 118.

[2]Harvesting Ants and Trap-Door Spiders, p. 119.

[3]Idem. pp. 123. 127 and 150, and Supplement, p. 245.

opportunity of observing the manner of enlargement of trap-doors made by the spiders which he studied, or that he did not offer some theory as an explanation. If the particles are cemented to the edge, it would be quite natural that the species of spider in my possession once made its door by first spinning a web across the mouth of the tube, and then weaving into it other material, as in the case of *N. meridionalis*; and that the habits, followed through life and successive generations, of making additions to the door by cementing particles to the edge, finally became so fixed that this mode of making additions to it became the permanent habit and type of construction of the trap-door from the foundation! The rapidity, ease, and intelligence manifested in this method of building up the door, piece by piece, certainly indicates a higher development of instinctive power. A perfect and neatly fitting and swinging door made in 1½ hours!

When I took the spider from her nest it was necessary to remove nearly all of the soil from the jar and take her from the lower end of the tube, as all efforts to attract her from the nest failed. As the soil was very loose and the nest not long made the walls of the tube collapsed. In ten days the spider was returned to the nest. Though the trap-door was capable of being used, and seemed to satisfy the spider's idea of the "fitness of things," it was in a very dilapidated condition. This agrees with what Mr. Moggridge says of the reluctance manifested by spiders to abandon an old nest. The examples cited by him are that if a door be pinned back, during the night a second door will be made; that if the nest be covered with earth the tube will be prolonged to the surface of the superimposed earth and a new trap-door will be made; and that in some cases nests become inverted, when, a door being made at the now upper end of the tube, the nest will have a door at each end![1] The conduct of my spider under another condition farther illustrates this feature. Wishing to observe the habit of the spider if possible while the door of the nest was closed, I prepared a glass test tube, $17^{m.m.}$ in diameter by placing, 4^{cm} from the mouth, a cork bottom, so that the spider might have something on which to stand while making the door. This, with the spider in it, I placed in the glass jar and surrounded it with earth to darken the walls, hoping thus, because of the firm smooth surface of the tube she would not line it with silk, and by

[1]Harvesting Ants and Trap-Door Spiders, pp. 121 and 122.

lifting the tube from the soil I could observe the position of the spider as it held down its door. The experiment was a decided success.

This was prepared at eleven o'clock on the night of Dec. 27, '85. Pieces of moss were strewn about the tube. By morning a perfectly fitting door, beautifully covered with moss had been constructed (Plate XXIV. Fig. 3). About this time many visitors came to see the spider, and in pulling at the door to show how persistently she would resist its being opened, the hing became loosened, and the door was pulled down upon her. She held on to the door with such tenacity that I pulled it into bits in my efforts to remove it from her grasp. It was removed Dec. 30, '85, and on the following night she built another as neatly as the first. The hinge to this became loosened and the door moved down about $5^{m.m.}$ from the mouth of the tube. Here she strengthened the hinge by spinning a broad piece of silk, the width of the hinge, from the door down on to the wall of the tube. Several times in endeavoring to open the door I tore pieces from its edge and in every instance the spider repaired it. Finally, when I wished to remove her from the tube I was obliged to push up on the cork bottom, and in this way crowd her out through the door. After this was done it was with some difficulty that she freed her posterior feet from the silk bag which she had constructed at the bottom, so firmly did she hold on.

I have this yet to add. In a note I have mentioned the wandering of the spider about in a jar of freshly prepared earth, Jan. 16. For three days she has been restless, and though several attempts have been made to dig a tube she has failed. I came to the conclusion that the soil was not such as she could work easily or satisfactorily. Wishing to have soil which would make a more desirable tube than the loose soil in which I saw the first nest made, I used a large proportion of fine plastering sand mixed with black earth. This was wetted, and pieces of moss strewn over the surface. She tried several times to take up pellets of the earth, but seemed to be disgusted with its crumbling. She then tried to bore a hole by pushing down with her mandibles while turning her body around. She evidently wished to hide her head from the light, for after making a hole 2^{cm} deep she remained with her head at the bottom. To-day, Jan. 14, '86, the soil in the woods having thawed sufficiently I prepared a jar of moist, ferruginous clay, very much like that of which

the nest is constructed that came from Pittsboro. Upon this I put a fine mat of fresh moss, covering the earth except a spot at one side 2½^{cm} in diameter. In this I placed the spider at noon. I then covered it from the light. As I returned to my room after dinner she was resting in a hole 3 ^{cm} deep which she had excavated, and small pellets of earth were placed against the moss at the mouth of the hole. She would not work during the day unless I covered the jar from the light. During the evening, by lamp light, I had the pleasure of seeing her make another door. It required about 1½ hours. Only one piece of moss was used and that I let drop into the hole while she was at work. This seemed very strange for the tube was the only place not covered with moss, and to save her the trouble of cutting the moss I had strewn loosened particles about the hole. In this case all of the earth used in the construction of the door was taken from the bottom of the hole. The door being made almost entirely with the clay was very conspicuous in comparison with the surrounding moss; though the door fitted very neatly, the tube being built up to a level with the top of the moss. This time instead of making the hinge against the side of the jar, it was made on the opposite side of the tube.

I was unable to understand how the resistance to opening the door was offered, if the spider fastened its fangs and *all* of its claws into the under surface of the door, as Mr. Moggridge states.[1] A reference to Plate XXIV. Figs. 3 and 4, will show the results I reached in the experiment when the spider was induced to make a trap-door to the mouth of a glass test tube. The portion of the tube from *b* to *c* was not lined with silk. The spider, evidently not admiring the cork at *d* for a bottom to her nest, carried in pellets of earth and bits of moss as shown at *g*. She then spun a short bag of silk, *f*, which was attached by the mouth to the walls of the tube at *c*, and rested on the piece of cork. The mouth of the test tube was lined with silk from the edge for about 5$^{m.m.}$ to 7 $^{m.m.}$. The ends of the silk lining at *b*, and the silk bag at *c*, were for some distance transparent so that I was enabled to see the spider fairly well. As can be seen in fig. 14, the spider clings to the bag of silk at the bottom (or walls of the tube) with the claws of her two posterior pair of legs, and to the under surface of the door with her fangs and

[1]Harvesting Ants and Trap Door Spiders, pp. 95 and 96.

the claws of her anterior pair of legs. By partially lifting the door I was enabled to see the hold upon the door, and when I pushed the spider out of the tube, as before stated, I found her feet entangled in the bag of silk. The manner in which this spider holds down the nest is precisely the same as that described by Emerton[1] in the case of *Cteniza Californica*, except that he states the "3rd and 4th pairs of legs are pressed out against the walls of the tube."

The nest of this spider belongs to the simple, unbranched type with shallow cork door. The door belonging to the nest in which the spider was caught (Plate XXIV. Fig. 1,) measures 3 to 4$^{m.m.}$ in thickness; the edge is beveled and fits neatly in the mouth of the tube. The door measures 25$^{m.m.}$ across near the hinge; the tube 60$^{m.m.}$ in length. The walls are badly collapsed and the lower edge ragged and open. It will be remembered that the spider was found in the earth below the tube when the nest was taken up in November. The first nest which the spider made under my observation was open at the bottom, and when I attempted to take her out, finding she could not hold down the door she attempted to bury herself in the soil at the bottom of the tube. The question naturally arises, Is this not left open as a last means of escape from enemies? I am inclined to think it is, in some cases at least with this species, as this is the only resort for safety after the door is open. Further observation is needed on this point. The trap-door of this nest is so hung that it tends to close itself. In Fig. 2, Plate XXIV. at *a* are patches of silk that are drawn on the stretch when the door is open. When all resistance is removed these tend to close the door.

The subject of the food of trap-door spiders is an interesting one, and much is yet to be learned of their habits in this respect. While I had the spider out of her tube I offered her several house flies, holding them by one wing, with the forceps, near her head. The struggles of the fly attracted her attention. With a quick sweep of the palpi and anterior pair of legs she would clutch the fly and place it between her powerful mandibles, crushing it immediately. She held some of these about one minute, but I very much doubt her having derived any nourishment from them. One of the smaller species of the flies belonging to the genus Tabanus was offered her. It seemed only to frighten her as she could

[1]Structure and Habits of Spiders, p. 45.

not be made to touch it even by being angered, but would turn and run away as if in great fear. After returning the spider to her nest, Dec. 8, I placed in the jar two ants and a small carabid beetle. The ants hid themselves in the earth. Dec. 14th, the beetle was still unharmed and I concluded the spider did not come out for food. I then lifted the trap-door and placed the beetle inside. Dec. 16, I found the broken hard parts of the beetle strewn about just outside the nest. It had been killed, the soft parts eaten by the spider, and the parts of the skeleton ejected from the nest. Jan. 17, '86, I placed a half dozen large yellow ants in the jar.[1] As they attacked her she would catch and crush them but I did not see that she ate any of them.

Jan. 2, '86, which was like a summer day at Chapel Hill, I went into the woods for the purpose of collecting some moss. While tearing up a large patch of this, at the foot of a tree, I discovered a hole which I thought to be the nest of a trap-door spider. I dug down into the tube and found at the bottom a spider belonging to this family. In the afternoon I found several nests and one more female spider, Under some stones I found a male. I placed them in jars of earth containing moss. One of the females escaped; the other built a nest and made a slanting double door, which might be compared to an outside cellar door. Each door is made of moss cemented with silk and hung by a semicircular hinge. These the spider will open and shut at pleasure, sometimes fastening them together with a thread of silk. In both of the nests in which I found these spiders, there were the remains of ants. I had intended to illustrate and describe farther the nests and habits of these found by myself at Chapel Hill, as they are lively creatures and seem to offer interesting objects for study as to habit, food and architecture. But as this article is already long, and I wish to make further collections and study their habits more closely in captivity I will reserve the subject for a future time.

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[1]The spider was not in her nest.

EXPLANATION OF PLATES.

PLATE XXIII.

Fig. 1. Spider, natural size: dorsal view.
" 2. Spider, natural size: ventral view.
" 3. Spider, natural size; side view.
" 4. Spider in the act of unloading a pellet of earth while excavating the tube. *a*, pellet of earth.
" 5. Spider applying viscid liquid to the freshly placed pellet of earth. *a*, spinneret.
" 6. Spider applying viscid liquid to the edge of the partially constructed door. *a*, spinnerets. *b*, door. *c*, pieces of moss.
" 7. Spider in the act of fitting to edge of the door a pellet of earth, *a*.
" 8. Trap-door showing eight concentric rings which represent the successive additions to the edge of the door corresponding to the enlargement of the tube. *a*, hinge

PLATE XXIV.

Fig. 1. Natural size of nest in which the spider was caught.
" 2. Trap-door open. *a*, bands of silk which tend to close the open door. *b*, claw and fang marks of spider made while holding down the door.
" 3. Nest made in glass test tube. *a*, hinge. *f*, bag of silk. *d*, cork bottom. *g*, pieces of moss and earth.
" 4. Spider in act of holding down the door, while in the nest. All natural size.

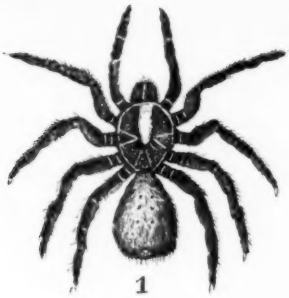
A FAMILY OF YOUNG TRAP-DOOR SPIDERS.*

(Pachylomerus, 4—spinosus.)

Two questions were asked by Mr. Moggridge about the habits of young trap-door spiders. For the answer to these he was unable to make any observations, so far as the record shows. The questions are; 1st, do young trap-door spiders make nests like those of the parent without being shown?

*This paper has been previously published in the Entomologica Americana, Vol II, Aug. 1886. (3)

PLATE XXIII.



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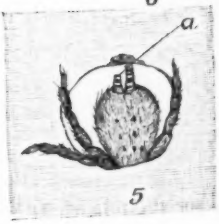

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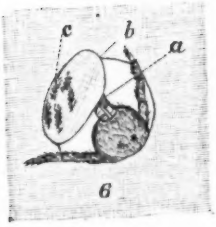

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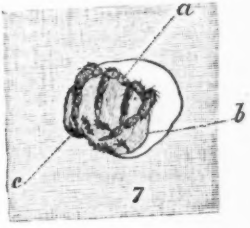

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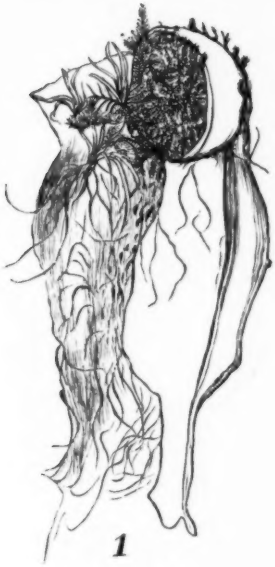
G.F.Atkinson del.

A new Trap door Spider.

PLATE XXIV.



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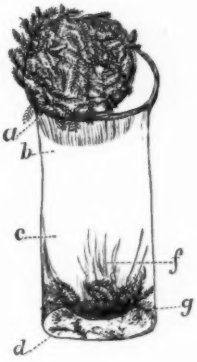

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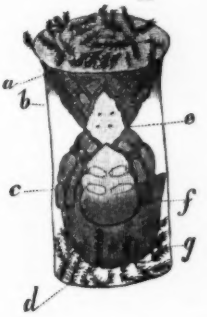

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G.F.Atkinson. del.

A new Trap-door Spider.

2nd, do the males of trap-door spiders make a nest with a trap-door when very young? To the first question we would almost unhesitatingly reply in the affirmative, without direct observation. In regard to the second, it is well known by those who have given much attention to the habits of trap-door spiders, that the mature males, at least, do not build trap-door nests, but seek a hiding place under stones, logs, etc.

There is also another question as to the constancy with which species follow a *uniform type* in the construction of their nests. Some naturalist make the different kinds of nests a partial basis for classification, and others are looking for differential characters manifested in the variationsof the trap-door; whether the door is horizontal; the hinge lower or higher than the distal part of the door sloping one side, etc.

The object of this paper is to present the variations produced by a family of 28 young trap-door spiders, in the building of their nests, which I have carefully observedand noted. I trust also to show that, from the labors of these little creatures, and of several mature ones, which I have had in captivity, a great deal of light is thrown on the questions stated above.

The family was captured by D. E. Woodly, student at Chapel Hill, N. C., March 17, 1886. The mother had either deserted her children, or had met with her death. The tube was doorless and near a decaying stump. The 28 childre n were living peacefully together in the silken cocoon whi ch had contained the eggs at the bottom of the tube. A fter keeping them together in a small vial for one day, I prepared a bottle of earth for each one. The bottles measure 1 ½ inches in diameter by three inches deep. In each about 1 ½ inches in depth of earth was placed. The earth was moist, loose, but smoothed over and gently packed to furnish a smooth surface for operations.

The following table shows the time of beginning and completion of the work of each. In column 4 is given the time when the work began which was carried to completion. Some began work earlier than here in dicated but abandoned it.

1	2	3	4	5	6
No.	Date Mar. '86.	Time placed in bot	Time when work began.	Time when trap-door was begun	Time trap-was comp'd
1	18	5 p m	Unobserved.	Unobserved.	Unobserved
2	18	5 p m	"	"	"
3	18	5 p m	"	"	"
			Mar 19, 3.30 a m	5 a m	5.15 a m*
4	18	5 p m	" 19, 12.30 a m	1 a m	2 a m
5	18	5 p m	" 19, 2 30 a m	4 20 a m	5 a m
6	18	10.30 p m	" 18, 11.15 a m	Mar 19, 12.30 a m	1 a m
				" 19, 3 55 a m	4.20 a m*
7	18	10.30 p m	11.30 p m	" 19, 12.30 a m	2 30 a m
8	18	10.30 p m	Mar 19, 12 30 a m	3 20 a m	4 a m
9	18	10.30 p m	" 19, 2 a m	3 20 a m	4 a m
10	18	10.30 p m	" 19, 7 a m	9 a m	10 a m
11	19	4.10 p m	4.15 a m	5.55 p m	7.30 p m
12	19	4.10 p m	" 20, 11 a m	Unobserved.	2.30 p m
13	19	4.10 p m	" 19, 4.30 p m	5.50 p m	6.30 p m
14	19	4.10 p m	" 20, 10 a m	1 p m	2.30 p m
15	19	4.10 p m	" 19, 5.18 p m	Unobserved	Unobserved
16	19	4.30 p m	5.15 p m	6 20 p m	"
17	19	4 30 p m	4 45 p m	Unobserved	"
18	19	4.30 p m	5.10 p m	5 50 p m	6.30 p m
19	19	6 30 p m	7.00 p m	9.15 p m	Unobserved
20	19	6.30 p m	Unobserved.	Unobserved.	"
21	19	6 30 p m	"	"	"
22	19	6 30 p m	9 20 p m	"	"
23	19	9 p m	9.50 p m	"	"
24	19	9 p m	9 25 p m	"	"
25	19	9 p m	Unobserved.	"	"
26	19	9 p m	Mar 20, 4 p m	Not noted.	Not noted.
27	19	9 p m	" 21, 10 p m	1 p m	5 p m
28	19	9 p m	" 20, 10 p m	11 a m	11 30 a m

* Nest was destroyed and another built.

Variations from the normal type. By the normal type is meant that which seems to be the simplest, most nearly perfect, plan of construction, is followed by a majority of those observed, and seems to indicate a *natural instinct*, a more potent influence of inherited habit in some, while in others the instinct seems to be latent at first and gradually unfolds with the dawning of consciousness! According to the normal type, the spider takes up pellets of earth with its mandibles, and turning around, places them upon the soil by the side of the tube, which is being dug; or carries or throws them to a short distance. Occasionally with its spinnerets it applies viscid liquid to the pellets and edge of the tube, much as an artificer would alternately place cement and bricks in the construction of a column. The trap-door is built in the same manner, by beginning, at one side of the

edge of the hole, a horizontal wall to which particles are cemented and pressed in shape to make a flat, circular, lid to the tube.*

By a study of Plate IV we shall see some of the variations from the normal type. Fig. 1, *a*, represents one of the spiders, natural size, *b*, section of a nest built after the normal type, door represented open, also natural size. All of the other figures, except 15 and 16, are magnified. In fig. 2, one side of tube, *a*, is extended above ground and carried over the tube. The door, represented open, is hinged at *b*; when closed it slopes downwards from the hinge attachment, fig. 3. This was the work of No. 3. The arched wall from *a*, was pressed in shape in the same way that the trap door is, so that when the spider began it at *a*, I thought it had begun the trap door, and made this entry in my notes: "At 4.30 door begun; two-thirds of the edge used for attachment of the hinge, making an awkward door." When the hinge was made at *b*, it was easy to see the arching of the wall was intentional. In fig. 10, the tube is curved above ground in a similar way, but the hinge is at one of the sloping sides, making a door that swings to the right and left instead of up and down. This was made by No. 25. Figures 4, 5, 6 and 7 represent the work of No. 15. A trench was dug, using the excavated earth for a wall on each side; the walls were then united by an arch over the middle, one end closed and a trap-door made at the other end. Fig. 8, represents the nest of No. 22, built in the same way as that of No. 15, except that at *a*, the hole was not entirely closed. No. 13 built what is shown in fig. 9. A trench with a wall each side was first built; in the middle of the trench was dug the tube and the door hinged at the base of one wall at *a*, with the distal part of the door elevated at *b*. Fig. 11, shows the work of No. 24; a trench was dug by the side of the glass with a wall on one side at *a*; on the other side earth was carried upon the side of the glass and attached in small lumps at *b*; *c*, represents the nest, a small tower against the glass. Fig. 12, was made by No. 26. This is interesting as being the only one showing the concentric "lines of growth" usually noticed in the doors of nests that have been used for a year or so. No. 14, first dug a shallow hole as represented at *b*, fig. 13; abandoning this it dug

*For description and illustration of the building of a nest and trap-door by P. Caribivorus, see Amer Nat for July 1886.

another at *c*; it then removed the earth at *d*, making a trench; next it began the tube at *c*, but soon abandoned it, began again at *b*, restored *d*, and completed the nest in the normal way. The following table shows the varying positions of the door when closed.

Horizontal: Nos. 1, 2, 4, 5, 6, 9, 10, 11, 12, 14, 16, 18, 19, 20, 21, 23, 27, 28.

Sloping downward from hinge attachment: Nos. 3, 7, 8, 15, 17, 22, 24, 26.

Rising from hinge attachment: No. 13.

Sloping door with hinge at one side: No. 25.

Table showing the kinds of nests.

Curved tube: Nos. 3, 8, 25.

Straight tube: Nos. 1, 2, 4, 5, 6, 9, 10, 11, 12, 13, 14, 16, 18, 19, 20, 21, 23, 24, 26, 27, 28.

Trench with arched walls: Nos. 7, 15, 17, 22.

Nests of mature spiders, of this genus made in captivity present some of the variations mentioned above, as also some of the nests found in a state of nature.

One of the most interesting things which came under my observation during the work of these spiders was the varying potency of instinct manifested in the aptness with which each performed the task of building its home. This will be best illustrated by giving a few of the more striking examples recorded in my notes. No. 6, was placed in the bottle at 10.30 p. m. and began digging the tube in the normal way at 11.15 p. m. It worked rapidly, sometimes aking up and unloading a pellet of earth in 10 seconds. Indeed it worked with as much ease, accuracy, and apparent thoughtfulness, as the mature one which I have described in the previous paper. Sometimes with its palpi it would flirt the pellet across to the opposite side of the bottle. It began making the trap-door at 12.30 a. m. and completed it at 1 a m.; one hour and forty minuts from the time it began work, and two hours and thirty minutes from the time it was placed in the bottle.* During the operation every movement seemed to facilitate the work. No. 19, was placed in the bottle at 6.30 p. m.: my notes read as follows:—"Began digging tube in normal way at 7.50. Does not seem to be satisfied with work, and begins in another place. This is done several times: 9.15 began making trap-door," etc. No.

*One completed the work in one hour and 20 minutes; and another 1 hour and 30 minutes.

26 was placed in bottle at 9 p. m., Mar. 19th. At 1 p. m., Mar. 20th, it began digging and soon abandoned this place for another. This it repeated as many as a dozen times, sometimes returning to the work and tearing away at the soil as if in a frenzy, and impelled by some irresistible power. Then suddenly leaving the spot it would wander and endeavor to climb the side of the glass; when it would as suddenly be seized with an irresistible inclination to tear away at the earth without any seeming purpose. Occasionally it seemed to work with more deliberation, as if it were gradually becoming conscious of a latent instinctive power! At 4 p. m. it continued work in one place until the nest was completed, but the door, which is represented in fig. 13, was barely hung together and was loosely hinged by three strands. A few days later I tore down this nest, when the spider went to work in the normal way and built a perfect nest. Upon this point alone it would be interesting to follow carefully the notes I have taken on all, but I fear it would make the article too long, so I will conclude this subject with reference to a few others. One without digging in the normal way pressed the dirt aside; buried itself, and then spun a bag of silk surrounding it. When removed from this it went to work in the normal way. Several others acted very much like this one, and No. 26.

These variations could not be attributed to a difference in the nature of the soil as in the case of variations noticed among adult spiders, when the soil at times was of a different character. Care was taken that the soil should be of the same compactness and moisture for each. In some cases a hard lump caused the spider to remove to another place, and in one or two instances the spiders waited so long before beginning work that the soil was too dry; pouring in water packed the earth too hard and it was necessary to loosen it before the spider could take up a pellet. With close watching and due allowance for conditions just mentioned there seems to be great variableness in the attitude which different young individuals at first show in the construction of their nest. In some cases the consciousness, if fit might so be called, of instinctive power flashes upon them when they first are made to shift for themselves; while with others there seems to be a greater or less development or dawning of the same consciousness.

Mr. Moggridge also asks at which end of the tube the spider begins to spin the silken lining? This pecies, so far

as I have observed, (I have watched over thirty individuals,) always begins at the upper end. I had several opportunities of witnessing this among the young ones, and one mature one,* when the spinning of the lining was done very beautifully. In fig. 14 a spider is represented in the act of spinning the silken lining at the upper part of the tube. When the viscid fluid coming from the spinnerets cools before it is applied to an object it forms a broad band or ribbon as it might be called; by elevating and depressing the body perpendicularly as shown in fig. 14, and touching the spinnerets here and there to the wall of the tube this ribbon of silk is fastened. By moving around the tube at the same time the lining is made complete for the perpendicular distance covered by the spider in its movements. Some times instead of elevating and depressing in the manner just described the spider will move around the tube fastening the ribbon in circles.

Figs. 15 and 16 represent a novel way of excavating a hole which I witnessed in the case of a mature spider. With its legs as supporters on each side of the tube it would elevate its abdomen in the air and hook its mandibles in the earth at the bottom of the hole; then revolving through a quadrant about the axis at *a*, fig. 15, it would bring the earth to the surface and push it off with its palpi, as shown in fig. 16.

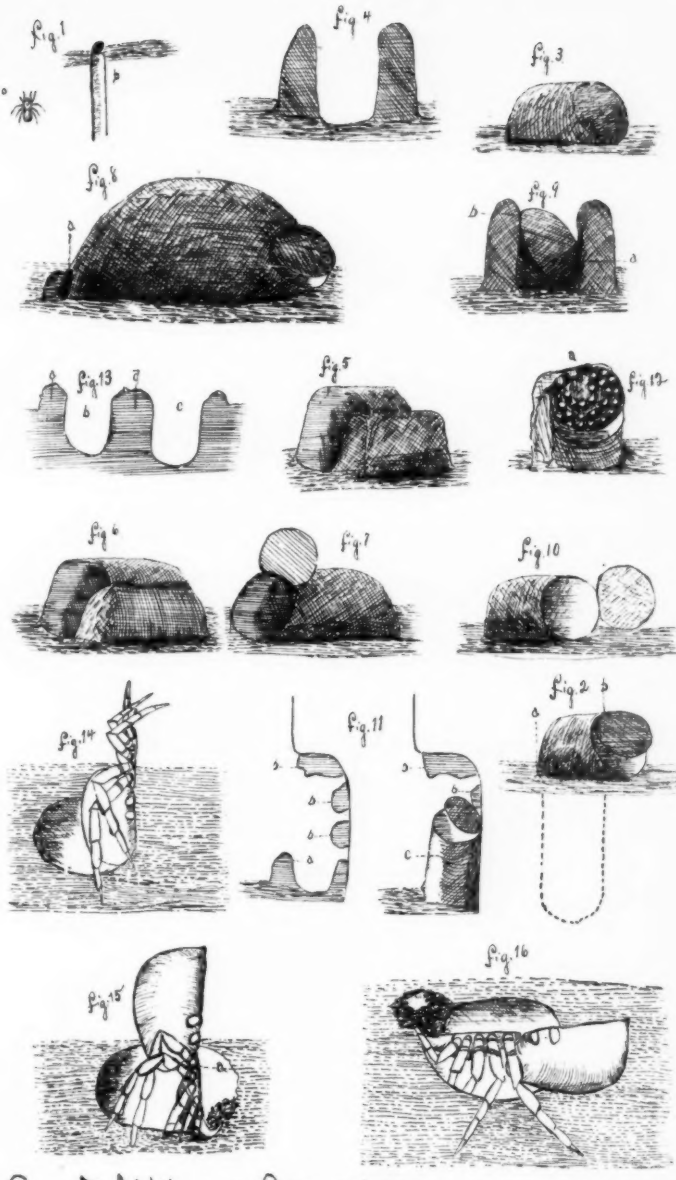
From this study we may conclude the young of trap-door spiders build their nests instinctively; that males as well as females build trap-door nests before the sexual character and habits are well developed, which in the case of the males make a somewhat wandering habit necessary in order to find the females; that young and old vary in making their nests from the normal type, so that the position or relative sloping of the door or tube could not be of any value in the classification; that this species does not use its legs to aid in spinning the lining to its tube, and that they spin the lining at the upper end of the tube first; and lastly that they vary in the degree of skill manifested as artificers and the maturity of instinctive power.†

EXPLANATION OF PLATE.

Fig; 1. *a*, Young trap-door spider, natural size *b*, section of nest with open door, built in normal way, also natural size. Figs. 2 and 3 curved

*P turris

†All of the observations made use of in the preparation of this article were made on three species. Descriptions of the new species collected, their nests, and food habits, I hope to have published in a subsequent article



Geo F. Atkinson: from nature.

tube with slanting door. Fig. 4, trench with wall each side seen from one end. Fig. 5, arch connecting walls. Fig 6, same, closed at one end. Fig. 7, same, with trap-door built at the other end. Fig 8, another built on same plan, but the first opening not quite closed, a loose flap at *a*. Fig. 9, tube dug between two walls, hinge at *a*, distal part of door at *b*. Fig. 10, curved tube with door hung so as to swing to the right and left. Fig. 11, section of bottle showing work of spider: *a*, wall, *b*, pellets of earth carried up and stuck to the glass, *c*, nest, a tower against the side of the bottle. Fig. 12, nest showing concentric "lines of growth," in the trap-door. Fig 13, *b*, first hole dug by spider, *c*, second one, *d*, wall between which was removed making of the excavation a trench, subsequently *d*, was restored and nest built in normal way at *b*. Fig. 14, spiders represented in act of spinning silken lining to the upper end of the tube. Figs. 15 and 16 P. turris adult spider taking a novel method of excavating a hole

NOTE.—The doors of all the young trap-door spiders' nests are very thin, from 2 to 3 mm. in thickness. One spider worked so rapidly that it would sometimes pick up and unload a pellet of earth in 8 seconds. As a rule they required a much longer time than this.

DESCRIPTIONS OF SOME NEW TRAP-DOOR SPIDERS; THEIR NESTS AND FOOD HABITS.

A few months after writing the previous article, "A new trap-door spider," I found a specimen which differed so markedly in color from the one, the subject of that article, and agreed so closely with the one described by Hentz as *Mygale carolinensis*,[1] now *Pachylomerus carolinensis*,[2] Hentz, that before having an opportunity to study them carefully I concluded the only difference was in color. Just after the article "A family of young trap-door spiders," was ready, I discovered that the two forms were different species; that the one called "A new trap-door spider," and the young spiders whose work has just been described in the Ento. Am. were both new species: the former I have called *Pachylomerus carabivorus*, and the latter *Pachylomerus 4-spinosus*.

The nests of *P. carabivorus*, *P. 4-spinosus*, have already

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[1] The Spiders of the United States, by Nicholas Marcellus Hentz M. D., Boston Journal, IV; p. 56, pl. VII, fig. 3.

[2] Beitrage zur Kenniniss der Territelariae, Ausserer, p. 147.

been described in the articles referred to. One thing, however, in regard to *P. carabivorus* is worth adding. The last trap-door made by this species as described on p. 20 was in sharp contrast, being made almost entirely of clay, with the surrounding moss. In a few days the spider made an examination of its work and found it had made a mistake in not placing moss in the door. It remedied this as well as possible by cementing moss to the edge of the door and pressing the ends down so that about half of the door was covered with moss!

Nest of Pachylomerus turris. March 5, '86, on turning over an old log, a sudden movement of an object downward attracted my attention, I looked and discovered a silken tube, with particles of earth and leaf mould attached extending above ground. On one side the silk was so extremely thin as to afford a "window" to the spider's house! It was through this that I had discovered the movement which attracted my attention. Nearly the entire remaining portion of the tube was covered with earth and leaf-mould, and here the silk was thinner than in other portions, yet intact. It seems almost incredible, yet from the wonderful intelligence manifested by these spiders, I was led to think this "window" had been purposely made: that the spider would sit by it and watch for beetles crawling about under the log, and seeing one would rush out through the door, seize its prey and return to its tower! It seems more reasonable when we consider that *Nidivalvata marxi* (see food habits of this species,) will nightly open its doors, remain out of sight, watch for passing insects, and rush out and seize them. The tube was about 8cm. in length, and there was only a very shallow excavation in the clay soil. The door is of the "wafer type," and was fastened down by silk, probably in the fall when the spider prepared for hibernating.[1]

In the evening I placed the spider in a bottle of earth. During the night it burrowed into the soil and made a rude door, which appeared more like a flap hung from one side of the mouth of the tube. On the evening of Mar. 7, I re-

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[1]Mr. Moggridge says in Harvest Ants and Trap-door Spiders, Supplement, p. 236: "I have on very few occasions, found the doors of a wafer or cork nest spun up during the winter at Mentone, and on digging have discovered the spider alive, though partially torpid, inside; but this I think is quite an exceptional event. I should like to know however, whether this becomes the rule in the case of the nests of those

moved a portion of the soil and placed in a portion of clay intermixed with loam, scattering over this a few bits of moss. I did not see the spider make the burrow, but next day saw it make two-thirds of a door, when I put an end to operations on that nest. The door was made practically in the same manner as that by *P. carabivorus*, but was a wafer door.

From the appearance of the tube and the soil about it in both of the nests made in captivity, I felt sure this spider did not dig the hole in the *normal way*. Accordingly, Mar. 8, I prepared a jar of wet clay. Up to 11 p. m. the spider had not begun work, but in the morning the work had not progressed too far for me to observe it. The spider begins the burrow in a manner similar to that practiced by *Nidivalvata Marxii* by pressing the earth aside from a central point with its anterior legs, using also its mandibles, but it is much slower in its movements than *N. marxii*. *Pachylomerus turris* is the spider represented in fig. 15 and 16 of Plate III. excavating in a "novel way." In making the trap door, sometimes when in this position it would cement the particle to the door by pressing on top of the door with its posterior legs, against the ventral surface of the cephalothorax. When the hole was about 3cm. deep it would occasionally take earth out in the normal way.

It will be seen that the habit of this spider is not wholly nocturnal in building its nest. During the month of July while I was at Ithaca, N. Y., I had a specimen of *P. carabivorus* make a nest for Prof. Comstock. This was made en-

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trap-door spiders which inhabit climates less favored than that of Mentone." He also speaks of a Lycossa that is said to close her nest in Cannes in winter. Latreille, in Mem Soc. Hist. Nat. Paris, (an VII, de la Republique) p. 124, says "L'araignee tarentule ferme aussi son habitation, mais cet opercule n'est pas mobile, et n'est construit que pour l'hiver." I have on several occasions found that *P. carabivorus*. after eating one or two beetles, fastens down the lid with silk. *Nidivalvata Marxii*, I have found fastens the door at times (See Amer. Nat. Vol. XX, p. 592.)

O. P. Cambridge, in Annals of Nat. Hist 1878, 5th series, Vol. I, p. 107, says that in all cases that came under his notice the upper extremity of the nest of *Atypus piceus* was without any perceptible orifice. He finally came to the conclu-ion that the spider gnawed its way out and then closed it with fresh thread again. These examples seem to indicate that spiders will very frequently at least fasten the doors to their nests during a period of rest, when inactive and more liable to be injured, when having had sufficient food, and perhaps sometimes at regular periods when not engaged in watching for food. It seems reasonable to suppose that in climates where the spiders are in a torpid state they would fasten their doors during this period.

tirely during the day. By reference to the young trap-door spiders it will be seen that *P. 4-spinosus* works just about as well in day as at night.

Nest of Nidivalvata marxii. The first one of this species which I found was taken Jan. 2, 1886, and which I have formerly mentioned as making in captivity a "folding door." In tearing up some moss I observed a tube in the bottom of which was the spider. Whatever there was at the upper end of the tube was destroyed in removing the moss, so that I have not had an opportunity to observe the door to the nest where the spider makes its nest in a patch of moss. I have found several nests of this species by gathering moss. In all there were what appeared to be branches just above the surface of the ground at the base of the moss. These I regard as avenues in which the spider would search, or lie in wait, for ants.

In captivity this spider made a very interesting nest with folding doors (See figs. 17 and 18 Plate IV) and I believe it is with some such arrangement that it closes its tube in a state of nature, for the spider makes use of it in catching its prey, as will be described in the food habits of this species. This kind of a door, I believe, has never before been seen or described, and adds one to the different types of nests which Mr. Moggridge has described and named.* The right name for this type should be "double door," but as Mr. Moggridge has used that name for a nest which has two doors, one at the upper end of the tube and another some distance below at the opening of a branch in the main tube, it cannot be applied to this one. So I have called this new type the *folding door nest*, from the manner in which the door opens and shuts.

This species begins the excavation of its tube by parting the earth from a central point with its anterior legs and palpi turning around at the same time so as to push the earth on all sides. It works with exceeding rapidity, and in this respect is in strong contrast with the members of the genus *Pachylomerus*, though the young ones of that genus work more rapidly than the older ones. When beginning the nest in a patch of moss the spider will dive down in the moss and begin turning rapidly in all directions, at the same time spinning threads to fasten together the pieces of

*Harvesting Ants and Trap-Door Spiders; and Supplement.

moss around and over it. I have watched four different ones make the nest, two beginning in moss which I had placed over the earth, and two beginning in soil. Two of these I had make a nest several times, and thus far every one has first entirely closed the entrance to the tube by building a sort of dome above it. Later, in one case a week, cutting through this and making the folding door.[1] Usually while at work near the surface of the earth it will burrow out in different directions and elevate the surface of the earth. This I think is partly for the purpose of providing a place to put the earth which it excavates from the lower portion of the tube as I have seen these filled up; and in one specimen, after the tube was about 2 cm. deep I observed the same habit of digging and cementing to the edge of the tube, as observed in the case of *Pachylomerus carabivorus* and 4-*spinosus*. This individual made the dome by carrying up three sides regularly until it had completely covered the entrance. Usually in making the dome earth is placed on and about the edge of the tube, occasionally applying viscid liquid and spinning threads over it. Then the spider would, with its anterior legs and palpi pull the edge over the tube. This operation would be repeated until the dome was complete.[2] When moss is convenient the door is made almost entirely of moss and silk; each door is a surface of a half circle, is hung by a semicircular hinge, and the two meet, when closed, in a straight line over the middle of the hole, as shown in fig. 18, Plate IV. Every night (I ob-

[1] NOTE.—In the Encyclopedia Britanica, 9th edition, 1875, Vol. II, p. 291, O. P. Cambridge says: "The present writer was once told by a gentleman who had formerly resided in the West Indies that trap-door spiders invariably made the tube and lid of one continuous, solid, homogeneous piece, and then cut out the lid with the falcers. This account, especially as coming from a non Naturalist seems improbable, a spider's falcers being in no way fitted apparently for such an operation" Where the silk lining was thin, it would be a very easy matter for a spider to cut through, and then repair the roughness by cementing on particles. It is probably an exaggeration to say that they "invariably" construct them in that manner, but I should not be surprised if some species made the trap-door in the manner described by this non "naturalist."

[2] I have never seen this spider press the lid on the end of its mandibles as does *P. carabicorus*. I think this shows the adaptation of the special armature of the mandbile of *P. carabicorus*, and related forms, for fastening the earth to the lid. *P. carabicorus* usually makes no thread in applying the viscid liquid to the door while adding particles, but puts it on as a *cement*. The large point of the mandibles, which is covered with short strong spines serves admirably to punch the earth irregularly into the portion of the door already made, and causing it to adhere firmly.

served one in my room for three months) the spider would throw open its doors as shown in fig. 17, Plate IV and in the morning close them. If I opened the door during the day time the spider would invariably come up and close it, but never immediately, and never did it offer to catch the door and resist its opening. When members of this genus build their nest under stones, as they sometimes do, if the stone is elevated from the earth in one place the spider builds the tube above ground to the under surface of the stone, and here makes some sort of door, I have never been able to see just what, but probably very much like the ones made in captivity. A longitudinal section of one of these nests which I found under a stone is shown in fig. 11, Plate IV, the surface of the ground at *a* and the mouth of the tube at *b*. On turning over the stone I saw what I thought was the cocoon of a moth, from which the insect had escaped at the upper end. I picked it up, and discovered the tube which I found about 12 inches deep, with the spider[1] at the bottom. This nest, perhaps inappropriately, I have called the *hall door nest*, because of the enlargement just within the entrance. This I consider would be of advantage to the spider in managing the door while catching an ant. The portion above ground was made of loam and leaf mold cemented with viscid liquid and lined on the inside with silk. So far as I have observed, the members of this genus line only that portion of the nest with silk which is liable to cave in near the upper portion of the tube.[2]

Nest of Myrmekiaphila foliata.

The nest of this species is not constant in type, and shows wider variation in different individuals than any of those thus far described; but when taken in connection with the food habit of the species there does not seem to be a very great departure from a common type.

The first individual was collected March 13, '86 by myself. In collecting specimens of ants and their root feeding "cows" (Aphides) which they were protecting through the winter, I found a trap-door on turning over a stone. The tube I traced down about 14 inches, when I came upon and struck the spider off at one side. In doing so I broke off a

[1] *Nidivalvata angustata.*

[2] I have observed the same thing with Myrmekiaphila foliata.

leg and palpus so that the spider died the next day. At the time I thought the spider must have underground galleries in which it hunted for ants similar to the galleries in the moss of the nest of *Nidivalvata marxii*. But since finding the nests of other individuals I think there must have been a branch from the main tube with a trap door, and the soil being so full of rocks I failed to find it.

The second individual I collected on the morning of Apr. 6, '86, while digging into a side hill with a southern exposure for white ants (*Termes flavipes*). Discovering a tube I traced it until I found at one side a trap door opening into a short branch. In this I found a fine specimen of trap-door spider. The nest I concluded belonged to the type called by Mr. Moggridge, "Double door branched nest," but differs from that in having a cork door instead of a wafer door. I did not see the door at the end of the main tube, if there was one, as the soil was very loose and rocky, and every trace would have been destroyed before finding the main tube.

The third individual was collected in the afternoon of the same day, by one of the students, D. E. Woodley. The tube ran under a stone, a trap-door was at the upper end, but the branch and second door was not seen. Mr. Woodley said, however, that it might have escaped his notice as the tube was not traced out very clearly.

The fourth individual I collected Apr. 6. On turning over a stone I saw what is represented in fig. 16, Plate IV, except that the trap door was closed, and the spider was in the tube a short distance below it. The space above the trap door is a portion of an ant's nest, *b* is the entrance from the surface of the earth ; *a*, *a*, is a broad hall-way leading off into galleries on the side. The spider had come down at *b*, undoubtedly during the night while the ants were quiet, unconscious of the purpose of their terrible enemy, dug the hole in the center of this hall-way, and covered it with a trap-door before the ants were stirring at the break of day. The soil was in a good condition for tracing out the tube, which I did very carefully and found neither branch nor second door, so that this nest was of the type *single cork door, unbranched nest*.

The fifth I collected on the same day and not more than 10 feet distant. Turning over a stone I saw a tube which ran down one of the perpendicular sides of the hole, in which the rock fitted, then along the bottom to near the center of where the stone lay. Here it disappeared taking a

perpendicular direction again. I ran a straw down this tube and felt the movements of the spider. The spider would not seize the straw, as they sometimes will, and soon I could no longer feel the movements. I then dug carefully around the tube, and at the depth of about ten inches struck the spider, splitting open its caput. This happened because the spider was in the branch: when I first ran the straw into the tubes she was in the main tube, and probably being frightened ran into the branch and caught hold of the door. This confirms what Mr. Moggridge believes to be the case with spiders making a double door branched nest, that when an enemy succeeds in getting entrance to the main tube the spider will run into the branch. This nest is represented in fig. 15, Plate IV. Though the tube is represented nearly natural size the length is much fore-shortened. The space represented by the dotted lines *a* and *b* was 10 inches for each. The spider was found at *b*; the cork door can be seen at *c*.

Another specimen was found, about which, unfortunately, I have no record or recollection, except that it was collected sometime during the spring. This, though I have not given it a careful examination I believe to belong to the same species. I left it in the possession of Dr. Geo. Marx, at Washington.

The specimen collected Apr. 6, I placed in a jar of earth to see what kind of a nest it made in captivity. For several days it showed no signs of working. Finally I found it buried in the earth much as *Nidivalvata marxii* is, when having just completed the dome over the tube, and from the appearance of things I think the burrow was started, and the dome made in the same way as in the case of that species. The next day in place of the dome, in which there was no moss, was a perfect cork door with an abundance of moss in it. The spider had evidently cleared away the dome, which was made of earth and silk, and made the door of new material.

When I lifted up this door the spider would catch hold of it. In a few days I found this door fastened down and that end of the tube filled with earth for a distance of 5 cm. The tube extended in a circuitous direction for 10 cm. or more where it came to the surface and was closed by another nicely fitting trap-door: I think the spider was alarmed at

[1]Harvesting Ants and Trap-Door Spiders.

the discovery of her nest, and attempted by this strategy to deceive her enemy. If the jar of earth had been more capacious, and a longer time given the spider, she might have made a branch and second door.

Food habits. I have not yet had an opportunity of making very extensive observations on the food habits of these species, and cannot say that each one is confined to the insect for which I am certain it has a special fondness as an article ofdiet. Of the species of *Pachylomerus* my observations have been confined to *P. carabivorus*. I have already stated the fondness which this species has for carabid beetles, and though killing several ants and flies did not use them for food. During July, while at Ithaca, N. Y., I fed several carabid beetles to a *P. carabivorus* which I had alive. June 20, I placed a *Pterostichus lucublandus*[1], Say,in the bottle containing the nest of the spider. During the night the spider came out of the nest, caugt the beetle, ate it and ejected the hard parts from the nest. July 1st, it disposed of a *Pterostichus Sayi*, Brulle. June 29 it ate a beetle of the genus *Chlœnius*. At another time it ate three good sized beetles of the genus Chlænius in one night.

The observatiion which I made on *Nidivalvata Marxii* in captivity are very interesting. I noticed that at night the spider would throw its doors wide open[2] as shown in fig. 17, Plate IV. One evening I placed several in the jar containing the nest. When an ant approached so near the door as to send communication to the spider of its presence, the spider sprang to the entrance, caught a door with the anterior legs

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[1] I am indebted to Prof J. A. Comstock for the identification of the species of beetles.

[2] The position of *Nidivalvata* in the subfamily *Eriodontinæ* shows its near relation to the *Atypinæ* I have often been struck with its likeness to the *Atypinæ*, especially in the kind of a nest it makes, and though I have never seen an *Atypus*, nor one of its nests, I have often concluded that from the form of its nest it must be somewhat similar to *Nidivalvata* in architectural habit, and that the presence of a door, or covering for the entrance to its nest instead of being wanting, has been overlooked; that in the cases where the nest was open, accident had removed the door. What O. P. Cambridge says in Annals of Nat. Hist. 4th series 1875, Vol. XVI, p. 240 241, seems to me to indicate that *Atypus* is very similar in habit to this genus Not only in the form of the nest, but in its food habit. He says that on one occasion a nest which apparently had no orifice was buried in a box of earth; subsequently the tube was observed with a wide open mouth, and again was closed the following morning The spider probably opens the doors at night to watch for food, and closes them in the morning as does *N. marxii.*

on either side, and pulled them nearly together, so that there was just space enough left for it to see the ant when it crossed the opening. When this happened, the spider threw the doors wide open, caught the ant, and in the twinkling of an eye had dropped back to the bottom of the tube with its game. This I saw repeated several times during the months of January and February. At one time I placed a large cricket in the jar. The spider made several attempts to capture it but was not strong enough. It would probably eat crickets when fortunate enough to catch one. I think also that it would eat small carabid beetles, for I found several in the moss where I collected the spider. I have found the remains of ants in the nests.

I have made no observations on *Myrmekiaphila foliata* in captivity, but from the location of their nests it is quite evident that the members of this species are extremely fond of ants, and seek to build their nests either directly in an ants nest or in close proximity to it. I think in some cases it is intended that the main tube shall be used as a passage for ants, so that by coming out of the branch the spider can capture its food, for it is certain in these which I have observed that the external door is either wanting or old and in a neglected condition, while the door at the branch is kept well repaired. If I am correct in this conclusion it would account for the apparent variation noticed in the kind of nest built by this species. In the nest represented in fig. 16, Plate IV, the entrance *b*, and the landing *a*, *a*, of the ants' nest answers for the main tube of the spider, and only the one tube and trap-door is required for the use of the spider.[1]

[1] NOTE.—There evidently is quite a variation, even with the same species, in the kind of a nest which trap-door spiders make. As these prove to be very intelligent creatures, I believe the vary in the construction of the nest as the conditions of their environment varies, and that they adopt that plan which provides for them the safest abode, and at the same time will serve them the best as a trap. At the same time we must not lose sight of a common type, which, with some useful variations, each species follows; though species of different genera may make the same kind of a nest, and be identical in food habit, species of the same genus may vary with regard to the common type; so that the use of nests, and food habits, becomes of less value than has been heretofore supposed by some for purposes of classification.

Mr. Moggridge says, "H. A. and T. D. Spiders" Supplement, pp. 236, and 237; the range and distribution of a species largely depend upon the nature of its food, and this will also be an indication of the rivals, etc.—'and in many cases even the *structure* and *position* of its dwelling place will be governed by this same all—important question of food supply.

Rev. O. P. Cambridge, at that time came to this conclusion, "and in

DESCRIPTIONS.

Prefatory Note. It is not surprising that in a collection of some forty specimens there would be found several species, nor that a large number of these would prove to be new and undescribed forms, where so little attention has been given to spiders in general, and especially those of the order *Territelariæ*, as has been given in America.

It has been a great pleasure to me to observe the nests and habits of so many of these creatures, which by their solitary and secluded life generally escape our observation. It has seemed necessary, that, in connection with interesting descriptions of their nests, architectural and food habits, these forms should be described and named. So interested have I become during the past year in the work of N. M. Hentz, that it would have given me more pleasure to find a specimen described by him than to find a new form. I feel sure that I have found one of his species, and possibly one other related species. I undertook the work of description with great reluctance, and have found it to be no small task. But my labors have been greatly lessened and I have been sensibly encouraged by the kindness of Dr. George Marx, of Washington, Prof. J. H. Emerton and Samuel Henshaw, of Boston. Dr. Marx loaned me works from his private library, Prof. Emerton placed for my study his excellent collection of Arachnological publications, and specimens for comparison, which are now in the Mass. Inst. Tech., and showed me further kindness in directing me to the most useful works in the Library of the Boston Natural History Society. Mr. Henshaw also aided me in the same way and gave me the use of the specimens of *Territelariæ* which are in the Museum of the Society.

I have also found works in the Boston Public Library which have aided me.

In the value of generic and specific characters I have been

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the present case it is very important, as well as interesting, to conclude with som certainty that differences of type in the tubular nests of the spiders Mr. Mogaridge has observed so closely and accurately, are joined to well marked specific differences etc. "Harvesting Ants and Trap-Door Spiders, Supplement p 301." Later, Cambridge doubts such close union of specific character and architectural habit, for he finds nests of *Atypus piceus* varying greatly in construction. (Annals of Nat. Hist. 1878, 5th series, Vol. 1, p. 107.) From nests made in captivity, I know that *Pachylomerus turris* and *Nidivalvata angulata* make different nests according as the environments change.

guided by those adopted by Anton Ausserer[1], and the Rev. O. P. Cambridge[2], who have given considerable study to members of the *Territelariæ*.

I have followed the classification adopted by Ausserer in his *Beitraege zur Kenntniss der Territelariæ*.

I subjoin, for clearness, a brief synopsis of his Classification.

Suborder *Territelariæ*. This was divided by Thorell into 3 families, as follows:

2, lung sacs..... .....*Cataldsoidæ*.
4, lung sacks,
a. Without spinnerets..... .....*Liphistoidiæ*
b. With spinnerets..... ..... *Theraphosoidæ*.

The family *Theraphosoidae*, Thorell, is further divided into three subfamilies as follows:

Maxillæ well broadened at the base, palpi inserted laterally, .**Atypinæ** Thorell
Maxillæ little broadened at base, palpi inserted laterally.....
Eriodontinæ Ausserer.
Maxillæ not broadened at base, palpi inserted on the end,.....
Theraphosinæ Thorell.

The *Theraphosoidae* are then further divided into two groups, based on the relative elevation of the caput above the throax.

a. Caput well elevated,..... ....*Epicephali*.
b. Caput not much elevated, ...*Tapinocephali*.

In specific descriptions I have endeavored to not repeat characters which seem at present generic, so that in most cases it will require both the generic and specific characters to identify a single species; for this reason I have given the characters of the genus *Pachylomerus*, established by Ausserer.

Family THERAPHOSOIDÆ, Thorell.

Subfamily Eriodontinæ, Auss.

1. Genus Nidivalvata, n. gen.
(*nidus*, nest, *valvata*, having folding doors.)
(Pl. V, figs. 8, 9, 10, 13, 23.)

Ceph'x little longer than broad; greatest breadth at middle, tapering very gently and equally to both ends; edges of posterior half slightly scalloped; small, deep, circular, depression in center from which radiate to edges of ceph'x 6 depressed lines quite well marked. Caput well elevated, sloping to thorax gently, not broadly arched as in *Myrmekiaphila*. In front, caput gently drawn to a short, blunt point about which the eyes

[1] Beitræge zur Kenntniss der Terrielariæ, Auss. 1871, and Zweiter Beitræg, etc., 1876.

[2] Encyclopedia Britannica, 9th, Ed. pp. 291 and 597, Harvesting Ants and Trap Door Spiders, Moggridge, and Supplement.

are crowded. Eyes can be better described by speaking of them as being in three groups; the anti-centrals a diameter or less distant and situated at the top and on sides of the hill; on each side of these, not far separated is a group of three eyes forming a crescent with the concavity toward the middle group; the eyes in this group nearly or quite touch each other. Fig 8, Pl. V, represents the eyes as seen from the front at an angle of 45° to a plane parallel with the base of the ceph'x

With this view the ant- and post-laterals form a trapezium, base at post-laterals one-fourth larger than opposite side; height about one-third of base, post centrals slightly in front of base of trapezium. Ant-laterals comparatively large; others varying in relative size in different species, and it may be found that the relative position varies also as in *Pachylomerus*. Maxillæ extended in front, but not so much as in *Eriodon*. Fig. 10 represents a maxilla showing insertion of palpus. Labium triangular, distal end rounded, longer than broad at base. Mandibles strongly kneed in front of perpendicular clypeus.

About half or less than half as long as ceph'x, broad and deep, armed with a comparatively strong fang; the inner edge only of furrow for reception of fang armed with teeth; upper and inner edges of anterior half armed with short spines, which also extend part way around base of fang.

Legs 4, 1, 3, 2. 4, 1, 2, 3, or 4, 1, 2, 3; palpi long. 3 tarsal claws. Claw of palpus unarmed. Abdomen short oval. Spinnerets 4, the upper pair long and slender.

1. **Nidivalvata** marxii. n. sp.[1] female 1 specimen.

(Pl, V, figs, 8, 9, 10, 13, 23.)

Ceph'x broadly oval 6 mm long by 5 mm. broad. Caput back of ocular prominence not perceptibly elevated, slope down to depression in center of ceph'x gradual. Caput in front not much contracted on sides

Radial depressions all quite deep; the posterior one of the laterals on each side, seeming to unite with the central depression. The depressions, though distinct in this specimen, have deepened somewhat by alternately being in alcohol and in the air while being studied.

In each anterior radial depression on sides of base of caput is a well marked depression, though not deep

Post-central eyes fully as large as the ant-centrals, eyes of the outer group almost or quite touching. Ant-laterals dark orange, remainder transparent, legs 4, 1, 3, 2. 3rd 12 mm., 2d 11½ mm. Sternum longer than broad, with three distinct circular punctures on each side. Abdomen broadly oval and bluntly rounded at each end; on ventral surface narrowed in front

Armature Very few hairs; short and fine on abdomen, longer and darker on the 4 distal joints of legs. Metatarsus IV, with a row of spines on each side, and one on under side, with additional spines at each end; tibia IV, with few long spines irregularly placed on upper side, 3 distinct rows, two on under side and one on anterior side, with extra spines at each end. Patella two double rows of spines on upper surface. Metatarsus III, 4 rows of spines, two upper and two lower edge: spines irregularly placed on upper side. Patella III, patch of spines on upper anterior surface, broadest at distal end; this is separated from a few spines on the posterior surface by an oblique denuded line. Metatarsus II, two double rows of spines, one on anterior surface, and one of long spines on under surface; tibia II and I, double row of long spines on under surface, and single row of short spines on anterior surface. Met-

[1] In honor of Dr. Geo. Marx.

atarsus I, three rows of long spines on under and anterior surface Palpus, tarsus and tibia a somewhat double row of long spines on each side; patella, one or two spines on anterior surface.

Labium separated from sternum by a deep furrow.

Colors. Upper surface Ceph'x and legs, olive brown. Under surface legs dull yellowish Sternum a little darker. Maxillæ dull rufous, with reddish hairs. Ocular prominence black. Abdomen dull yellowish underneath, brownish yellow above, with two rectangular rich dark brown spots on anterior end Mandibles rufous. Colors little changed in alcohol, not so bright however, and marks on abdomen disappeared.

2. **Nidivalvata angustata** n. sp. female 2, specimens.

Ceph'x oblong, 5¼ mm long by 4 mm broad. Caput in front below eyes perceptibly narrowed; caudad of ocular prominence perceptibly elevated, making the descent to the thorax steeper than in *N. marxii*. Legs 4, 1, 2, 3. Anterior central and lateral eyes dark, the others light; posterior centrals much smaller comparatively than in *N. marxii*, and the lateral groups of three distinctly separated. Radial furrows on thorax not so deep as in *N. marxii*. Otherwise the same.

II Genus **MYRMEKIAPHILA**, n. gen.

(*murmekia*, ants' nest or hill *philos* loving)

(Pl, V, figs. 6, 7, 12, 14 and 22.)

Ceph'x perceptibly longer than broad, nearly ⅓: crescent shaped depression ⅓ distance from posterior edge, convexity caudad, ends not so extended as in *Pachylomerus;* 6 radial lines, sometimes quite indistinct. Greatest width about the middle, narrowing gently to the anterior end, and more perceptibly toward posterior end

Caput large, high and broadly arched in the anterior ⅓, then steeply descending to depression and narrowing on the sides to this point.

Eyes. Anterior and posterior laterals forming a rectangle, the height of which is equal to two fifths the base. Ant-laterals oval, largest; post-centrals near the post laterals; ant-centrals in a line about ⅓ from base of rectangle. Legs 4, 1, 2, 3. Labium, trapezoidal, shorter than broad at base. Maxillæ extending forward not quite so much in proportion as in *Nidivalvata*. See fig 12, Plate V.

Mandibles, half or more than half as long as ceph'x slightly kneed in front of margin of caput, armed with a strong fang.

Inner edge only of groove for reception of fang armed with short teeth; front of mandible, on the inside of the insertion of fang drawn out into a three cornered toothed projection, much as in *Pachylomerus*, but a little smaller; short teeth along anterior half of inner upper edge of mandibles, and few at base of fang. Abdomen elongate, cylindrical, tapering gently to each end. Spinnerets 4, upper pair medium size and length.

I have been somewhat in doubt about placing this genus in the subfamily *Eriodontinae*, as it has some affinities with members of the subfamily *Theraphosinæ*, division *Ægicephali*. But I think, after a comparison of the maxillæ, with those of *Cteniza, Nemesia, and Eurypelma*, some species of which have a prolongation of the inner distal end, that the character of the maxillæ would place it in the subfamily *Eriodontinae*. If, however, it should prove to belong to the *Theraphosinae*, it would constitute a genus related with, *Aepycephalus, Cteniza, Cytocarenum*, and *Cyrtauchenius*, in the

group *Aepycephali*. It can, however, be separated easily from these genera by the following characters.[1]

Aepycephalus. "Head high and somewhat pointed, ceph'x broad as long, side eyes form a trapezium, lip broad as long, etc."

Ctenizа "Side eyes from a trapezium. Lip somewhat three cornered, spinnerets short and thick Abdomen great, eggforme l, etc."

Cyrtocarenum. "Ceph'x as in *Ctenizа*; but head broader in front. Eyes occupy whole breadth of head, abdomen and spinnerets as in *Ctenizа*, etc."

Cyrtauchenius. "Form of Ceph'x. and position of eyes as in *Cyrtocarenum*, mandibles not drawn into a point, etc."

As the nesting and food habits singularly resemble those of members of the genus *Nemesia*, and the form of the abdomen also, it might be confounded with that genus, which belongs to the group of *Theraphosinae* called *Tapinocephali*, as *Nemesiai*, as being related to the genera above mentioned represents the passage from the *Aepycephali* to the *Tapinocephali*. The generic characters given by Ausserer[2] however easily distinguished it.

Nemesia. "Head low, little elevated above the thorax. Depression with the concavity behind"

The specimen of *Nemesia caementaria* which I saw in the Museum of the Boston Soc. of Nat. Hist. is readily distinguished generically from this.

1. **Myrmekiaphila foliata**, n. sp. female 5 specimens. (Pl. V, figs. 6, 7, 12, 14, and 23)

In addition to the generic characters are the following specific characters Anterior central eyes[3] situated from each other about one diameter. Posterior lateral eyes a little larger than the ant-centrals. Post-centrals slightly angulated a little smaller than the ant-centrals, each one about a diameter distant from the corresponding post lateral, and situated a very little cephalad of the base of rectangle bounding the lateral eyes. Ant centrals on point of hill higher than the others. Ant-laterals lowest; these and the post-laterals situated at base of the low hill for the eyes.

Legs of one of largest specimens. 4th, 21 mm. 3d, 14½ mm. 2d, 16 mm 1st, 17 mm., palpus 11 5 mm. Ceph'x 9 x 7 mm.

In the anterior radial lines, on each side of the caput is an elongated shallow depression. Two lateral radials on each side show a long, narrow, shallow depression, post radials indistinct in some Edges of ceph'x slightly crenate, and showing shallow, irregular depressions: posterior margin emarginate. Caput 3.5 mm. elevated above thorax.

Sternum 5 mm. long by 3.75 mm. broad, broadest part one-third distance from posterior end, distinctly angled. Labium slightly emarginate. Abdomen 10 mm long by 7 mm. broad.

Armature. Very few hairs, more perciptible on abdomen, and still more so on the three and four distal joints of the legs, where the hairs are

[1] Beitræge zur Kenntniss der Territelariæ, Auss pp. 150, 151, 152, 156 and 161.

[2] Beitræge zur Kenntniss der Territelariæ, Auss. p. 165.

[3] It seems unnecessary to repeat the description of the eyes so far as given for the genus. Some variation should, however, be allowed for other species which may be found.

darker. Tarsus IV one or two spines on anterior side. Metatarsus IV with four or five long spines on under side, distal end 1 or 2 near centre. Tibia IV with scattered stiff hairs. Patella IV, upper and anterior side with numerous slender spines, with quite a strong base. A broad longitudinal denuded space on upper side, divides this patch of hairs Femur IV with a number of spines on distal upper end. Tarsus III, 2 spines on under side. Metatarsus III, 1 or 2 spines on under, distal end, 1 or 2 more near middle; two rows 3 or 4 spines each on upper anterior, and posterior edge Upper surface of tibia and patella III, covered with spines, which are divided into two patches by an oblique, denuded, narrow space. Tibia III, shorter than patella III. Tarsus II, 1 or 2 spines on posterior under edge; metatarsus II and I with 2 or 3 spines on under, distal end, and 2 or three near middle. Dense row of hairs on anterior and posterior side of tarsus and metatarsus I; palpus, tarsus as in I; tibia with spine on under distal end, and one or two near middle Labium separated from sternum by a deep furrow. Maxillæ and labium with very short, brown, strong spines at the oral extremities

Colors Ceph'x dull olive with a rufous tinge; legs more decidedly rufous, except the femora which are paler and indistinctly tinged with green. Mand bles, sternum, maxillæ and labium decidedly rufous. Ends of mandibles darker Ocular prominence black; posterior eyes light; others usually black. Abdomen dull yellowish; broad longitudinal dorsal band of delicate brown, from which branch on each side 7 bands of same color extending down midway of abdomen. Above colors from a coholic specimens. In some specimens the alcohol has entirely effaced the foliation on the abdomen, but it was distinct in all the specimens when alive. When alive the femora were of a delicate light, olive green.

Subfamily **THERAPHOSINÆ.**

Group *Æpicephali*

I. Genus *PACHYLOMERUS* Ausserer.

"Cephalothorax nur wenig länger als breit, lang, nach hinten allmählig abfallend. Die halbkreisförmige, nach vorn geœffnete Rueckengrube etwas hochliegend, da von hier der Thorax nach hinten noch fast unter demselben Winkel sich abdacht wie der Kopf, während bei verwandten Gattungen hinter der Grube der Thorax fast horizontal verläuft.—Augen etwas gedrængt, auf niedrigem Huegel. Die vier ovalen Seitenaugen die grœssten, mitsammen ein Rechteck bildend, dessen Hœhe gleich der halben Basis. Vordere Mittelaugen hoher stehend als die Seitenaugen. Mandibles stark, wenig länger als hoch, in eine mit Dornen bewaffnete Spitze vorgezogen. Falzrand beiderseits mit einer Reihe starker Zæhne bewaffnet. Lippe so lang, als am Grunde breit, vorn zugespitzt. Die Extremitæten der beiden Hinterpaare auffallend verdickt, ihre Schenkel in der untern Hælfte bauchig aufgetrieben. Tibia III kurzer als Patella III, oben an der Wurzel mit tiefem Eindrucke. Die beiden vorderen Fusspaare und die Palpen female etwas schwach, ihre beiden Endglieder unten flach and beidereits mit einem breiten Bande kurzer, stærker, dichtgedrængter Stacheln bewaffnet. Abdomen mæssig gross, eiformig, Spinnwarzen vier, etwas dick und kurz,"[1]

Ausserer takes *P. glaber* Dall, as type of this genus and says "ob die uebrigen vorlæufig hier eingereihten Arten wirklich hierher gehœren, lasst sich bei den etwas mangelhaften Beschreibungen nicht mit voller Sicherheit bestimmen."[2]

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[1] Beitræge zur Kenntniss der Territelariæ, Auss., p. 145 and 146.

[2] Idem, p. 146.

P. carolinensis Hentz, was one of those to which he refers. I think he was right in placing it in this genus, but for the relative position of the eyes, aud some slight difference in the form of the labium there should be allowed some variation in generic character, which he undoubtedly would have done, had he the opportunity to see the specimens.

1. Pachylomerus carabivorus, n. sp female. 5 specimens. (Plate V, figs 1 and 4, and 20.)

Eyes. Anterior and posterior laterals forming a trapezium; base of which formed by the post-laterals one-fifth longer than the opposite side. Height about one-third of base. View of eyes taken perpendicularly to a plane parallel with the ventral surface of the ceph'x. With this view the ant- and post lateral eyes appear elliptical in outline; but viewed from a point toward which each eye may be said to 'look" they are nearly circular in utline, and appear like "dormer windows," from the arched portion of the caput for each one. Fig. 3, Plate V, represents position and relative size of the eyes as seen from the view explained above; the arrows indicate the direction from which the greater number of rays of light enter the eyes. A line through the center of the ant central eyes would pass a little above a line half way between the base and opposite side of the trapezium; ant-centrals are situated from each other, and from the ant-laterals about one diameter; receive the rays of light directly from above. Post-lateral eyes in line with base of trapezium, or a trifle anterior in some specimens, receive the rays of light from a point caudo-dorsal. Ant-lateral, largest, ant-central and post-lateral of about equal size, post-central smallest, though in one specimen they are of equal size with the ant-central and post-lateral.

Ceph'x a liitle longer than broad at widest part. In one specimen 9 mm. x 8 25 mm., another 11 mm x 10 mm., &c. U-shaped depression situated about two-thirds of the distance from the anterior margin of the caput. Base of ceph'x 3.5 mm; posterior angles quite sharply defined; lateral edge, from posterior angle to point of greatest width, straight Greatest height of ceph'x, 6 mm. Mandibles 3.5 mm. long x 3 mm. deep. Abdomen 12 mm. long, whole length of spider 24 5 mm. Legs: 1st, 16 mm; 2d, 15.25 mm; 3rd 15-25 mm; 4th, 19 5 mm. These are measurements taken from one individual. In some the legs are 4, 1, 2, 3.

Armature. The legs have few hairs, though more abundant on tibia, metatarsus and tarsus, of all the legs, and patella III and IV.

Patella IV on sides of proximal half covered with very short spines. Anterior side of metatarsus and tarsus IV slender spines; a few spines on under side, distal end of tibia IV. Trochanter III with a short papilla. Anterior side and upper distal end of patella III, whole upper surface of metatarsus III, and distal end of tibia III, covered with short, strong, black spines. On upper side of proximal end of metatarsus III is an elongated denuded spot, which seems to be the miniature of the smooth depression at proximal end of tibia III; tarsus III with few spines. Tibia, metatarsus and tarsus of II and I, and tibia and tarsus of palpus, with dense row of short, strong, black spines on anterior and posterior sides

Sternum with few hairs on edge, longer than broad, in one specimen 6.25 mm. by 5.75 mm., sharply angled between the articulation of the coxæ; greatest breadth between coxæ II and III.

Maxillæ longer than coxa I; at edge of base a clustered row of short, strong, brown spines; densely hairy with rufous hairs on anterior edge. Labium broadest at base, distal end truncate, anterior angles well

rounded; as long or nearly as long as broad at base; armed near distal end with a few spines similar to those on the maxillæ; separated from the sternum by a deep furrow.

Colors. When alive. Ceph'x and legs deep glossy black. Abdomen light brown. Ends of mandibles, hairs on end of mandibles, and on anterior edge of maxillæ reddish. Patella IV also reddish on upper surface. Under parts lighter colored. Membrane connecting legs to ceph'x and the joints of the legs whitish. When placed in alcohol the glossy black after a while disappears, and becomes a dark rufous brown, ends of legs remaining darker because of the presence of numerous very short, black spines.

Pachylomerus carabivorus. var. **emarginatus,** n. var. (female 1 specimen.)

This seems to be a varietal form of *P. carabivorus*. Labium trapezoidal, anterior corners rounded; shorter than broad at base. Ceph'x nearly as broad as long, 10 mm. long. Marginal configuration as in *P. carabivorus*, except that the posterior margin is strongly emarginate. While upper portion of ceph'x seems to be elevated, showing quite a breadth of membrane which connects it with the coxæ. Middle portion of caput, perceptibly elevated and broadened a little caudad of the eyes. Legs: 4th, 23.5 mm; 3rd 19.25 mm; 2d, 18.5 mm; 1st, 20 mm. In front of the U-shaped depression the caput is emarginate, the depression extending for a short distance cephalad in the median line. This is seen to a certain extent in some good specimens of *P. carabivorus*. Otherwise as in *P. carabivorus*.

Pachylomerus carolinensis, Hentz. female 1 specimen. (Plate V, figs 2 and 3, and 20.) Beitrage zur Kenntniss der Terretariæ, Ausserer, 1871, p. 147. Mygale carolinensis, Hentz, Boston Journ. IV, p. 56, pl. VII, fig 3.

This specimen I am convinced is the same as the one described by Hentz as *Mygale carolinensis*. The description is very imperfect, and I take this opportunity of making it a little more complete, and easy to identify. His description is as follows: "Brownish, very glossy; cephalothorax with two slight impressions near the base; abdomen blackish, not glossy; third joint of the third pair of legs very short and crooked; feet 4, 1, 3, 2." The spinal armature is the same as in *P. carabivorus*, but the ceph'x and arrangement of eyes are quite distinct. Ceph'x longer in proportion to width than in *P. carabivorus*, 10 mm. x 8 mm. in this specimen. U-shaped depression situated more than two-thirds the distance from anterior margin of caput, making caput larger in proportion. In the curve of the U shaped depression, there is scarcely any depression; a very faintly depressed line, which is quite readily seen because it is very dark, connects the two well marked depressions at the anterior ends of the U. As Hentz's specimen was a small one, these depressions would be smaller than in the specimen I have. Had it been a well marked U-shaped depression, he would have noted it, as he has in the case of *Maygale trancata*.[1]

Caput caudad of eyes slightly elevated, making the slope quite steep.

Radial depressions distinct, straight. Base of ceph'x 4 mm; angles not sharply defined; lateral edge from posterior angle to point of greatest breadth curved, with convexity outward, fig. 2, pl. V, represents the ceph'x of this species. By comparing it with fig. 1, can be seen the differences of the two species in the configuration and markings.[2] Fig. 3

[1] Boston Journ. IV, p. 55. Spiders of the U. S. N. M. Hentz, p. 16, pl. I, fig 1.

[2] The curvature of the lateral radials I do not think is constant.

represents the eyes of *P. carolinensis*; fig. 4 of *P. carabivorus*; fig. 19 tarsal claw, spur at base with a small spine on each side at its base; distad of this a spine divided at the end Labium as long or longer than broad at base.

Eyes. Ant- and post-laterals form a trapezium as in *P. carabivorus*, but the ant centrals are situated on a line halfway between the base of the trapezium and the opposite side; the post-laterals and centrals form a curved line with convexity caudad, instead of a straight line as in *P. carabivorus*.

Sternum as broad as long, 5 mm., broadest part one third from caudal end.

Mygale solstitialis.[1] Hentz: I am inclined to think, is the male of this species. The depressions in the ceph'x are similar, the difference in the lengths of the 2d and 3rd pair of legs is not of much specific importance in many species. The depressions on the abdomen are just what will appear in any of these species, when the abdomen becomes small for want of food, or after the depositing of eggs. In nearly all specimens either one, two, or three, or more pair of circular depressions can be seen. When the abdomen shrinks the space between the depressed dots of each pair becomes depressed in the form of a rectangle as seen in Hentz's figure of *Mygale solstitialis*. The difference in color of the two is not of specific importance, for the young of *P. carabivorus* have a brownish ceph'x, the old a glossy black, and when transferred to alcohol, this soon changes to brown.

Pachylomerus turris, n. sp. female, 1 specimen. (Pl. V, fig. 5) Ceph'x 6.5 mm. long x 6 mm broad. Marginal configuration as in *P. carabivorus*; lateral radial depressions in form of crescents with the concavities caudad; anterior radial depressions indistinct, but marked by a deep, small cylindrical puncture; armature same as *P. carabivorus*, with the exception of the lack here and there of a few spines, which may be accidental.

Sternum nearly as broad as long, distinctly angled between articulations of coxæ. Labium shorter than broad at base, nearly triangular, separated from sternum by a furrow.

Eyes. Upon the arrangement of the eyes is laid the greatest stress in establishing this species. Ant- and post laterals forming a rectangle; posterior row curved with the convexity caudad.

Tuft of hairs on clypeus with few hairs; also very few hairs or signs of their having been any, in the three lines caudad of the eyes.

Pachylomerus 4-spinosus, n. sp (Pl V, fig. 21.)

Eyes as in *P. carolinensis*. Legs 4, 1, 3, 2, tibia III with depression at proximal end, but distal end not enlarged as in the other species. Armature very distinct from the other species. Patella IV with a number of spines; distal end of patella and metatarsus III, two spines; two on proximal end of metatarsus and two or three on distal end of tibia III; row of spine on each lower side of II and I, arranged thus in each row, one on tarsus, two on metatarsus, and two on tibia; palpus with a row

[1] Boston journ. IV. p. 56. Spiders of the U. S. N. M. Hentz, p. 17, pl. 1. f. 3.

on each lower side, arranged 3 on tarsus, 2 on tibia, one on patella, and one on femur. Spines at base of maxillæ and on labium as in the other species of *Pachylomerus*. All the spines on the legs are m dium length, and not short as in the other species. Ceph'x and l gs pale rufous, abdomen l ght brown. Specimens young. Palpal claw is shown in fig. 21, plate V, at base is a large short spine, which has four divisions at the terminal end, the distal one the longest, and the others decreasing successively in length.

EXPLANATION OF PLATE V.

Fig. 1 Ceph'x of *Pachylomerus carabivorus*.
" 2. " " " *carolinensis*.
" 3. Eyes of " "
" 4. " " " *carabivorus*.
" 5. " " " *turris*.
" 6. *Myrmekiaphila foliata*, dorsal view.
" 7. " " eyes of.
" 12. " " maxill e of.
" 14. " " side view.
" 9. *Nidivalvata marxii*, dorsal view.
" 8. " " eyes of.
" 10. " " maxillæ of.
" 13. " " side view.
" 11. " *angustata*, nest of.
" 15. Nest of *Myrmekiaphila foliata*; dotted line at *a* represents bottom of place where stone lay. Space represented by dotted lin s *a* and *d*, much f re-shortened; *b*, where spider was caught; *c*, trap door.
" 16. Nest of *Myrmekiaphila foliata* in an ant's nest; *a*, landing in ant's nest, leading off into galleries; *b*, entrance to ant's nest, *d*, tube of spider; *c*, trap-door.
" 17. Nest of *Nidivalvata marxii*, open.
" 18. " " " " closed.
" 19. Palpal claw fema'e, of *P. carolinensis*.
" 20. " " " " *P. carabivorus*.
" 21. Palpal claw of *P. 4-spinosus*.
" 22. " " female of *M. foliata*.
" 23 " " " " *N. marxii*.

Figs. 1, 2, 6, 9, 13 and 14, about natural size.

SOME NEW SALTS OF CAMPHORIC ACID.

I. H. MANNING.

Although this acid has been known for over one hundred years, comparatively few of its salts have been prepared and studied. The present work was undertaken with a view of extending this list, but was interrupted before very many additions could be made.

The camphoric acid was prepared, according to the directions of Wreden, by dissolving 150 grams of camphor in 2 litres of nitric acid, sp. gr., 1.27, and heating the solution 50 hours on the water bath. The liquid was then satuated with sodium carbonate, filtered, neutralized with hydrochloric

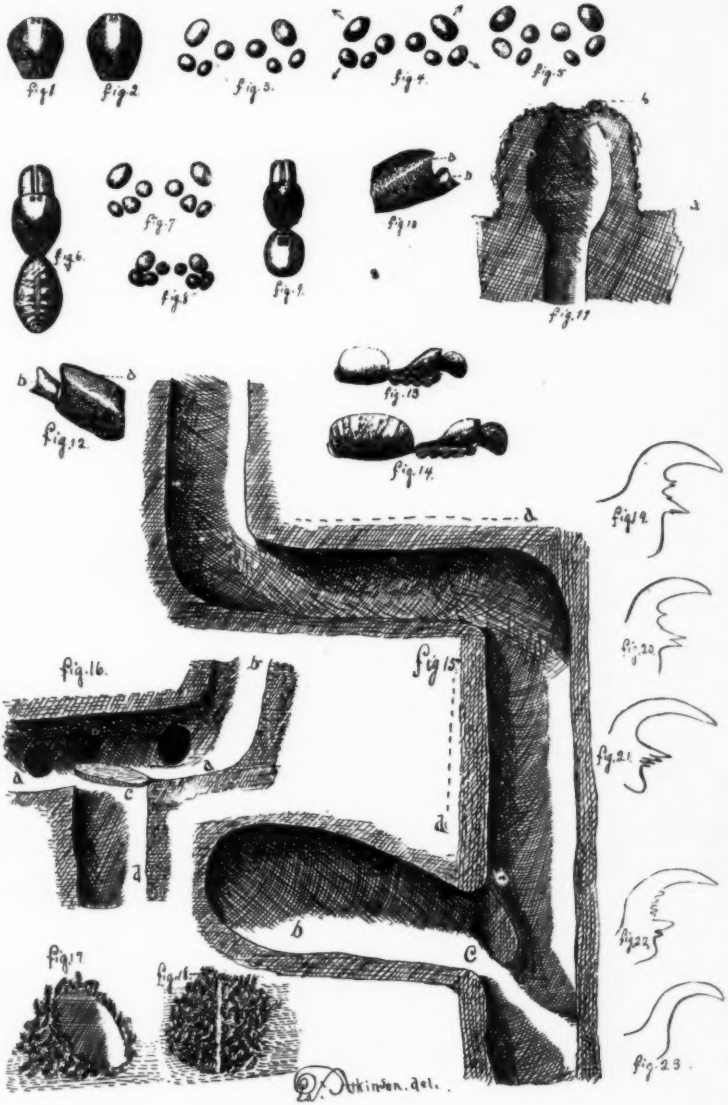
fig.1
fig.2
fig.3.
fig.4.
fig.5
fig.6.
fig.7
fig.8
fig.9.
fig.10
fig.11
fig.12.
fig.13
fig.14.
fig.15
fig.16.
fig.17
fig.18
fig.19
fig.20
fig.21.
fig.22
fig.23.
W. Atkinson. del.

acid, and the separated camphoric acid purified by crystallizing from water. The yield was about the same as that obtained by Wreden, when great care was exercised in the purification by crystallizing from water. The pure crystals gave the melting point 176°c. (uncorrected). A ten per cent. solution of caustic potash was saturated with camphoric acid and the solution of potassium camphorate so obtained was used in preparing the other compounds.

MANGANESE CAMPHORATE. When a few drops of potassium camphorate were added to a nearly saturated solution of manganese sulphate in a small watch-glass, no precipitate was formed until it had been heated on the water-bath. A white amorphous precipitate was then gotten, which was easily soluble in cold water. This could always be reprecipitated on heating. In preparing the salt on a larger scale the mixture of potassium camphorate and manganese sulphate was heated to precipitation and the precipitate well washed with hot water. The precipitate was then dried at 100°. If exposed in the moist condition it showed browning. There was a slight discoloration even when rapidly dried. At 15c° decomposition was very slight; at 200° it was marked. When some of the purified manganese camphorate was dissolved in water and evaporated over sulphuric acid a crust of the salt was obtained, but no crystal.

Analysis.

I. .2790 grammes of substance gave .0859 grammes, Mn_3O_4
II. .4460 " " " " .1330 " "
III. .4375 " " " " .1330 " "

I and III was determined precipitation as carbonate, II by ignition.

	p. c. Mn.	calc.	found		
Mn. $C_{10}H_{14}O_4$		23 07	I. 22.07	II. 21.39	III. 22.50

As it was very difficult to wash away all of the potassium camphorate the low results are probably due to the presence of the same as an impurity.

CHROMIUM CAMPHORATE. On adding potassium camphorate to a solution of chromium sulphate a heavy precipitate of a bluish-green color is formed. This is not very soluble and can be thoroughly washed with cold water. It can be dried at 100°c. losing all water at this temperature. Before reaching 150° slow decomposition sets in.

Analysis.

I. 4280 grammes of substance yielded on ignition .0810 grm. Cr_2O_3
II. 1 6370 " " " " " " .134) " Cr_2O_3

	calc	found in I.	found in II.
$Cr_2(C_{10}H_{14}O_4)_3$ p.c. Cr	14 81	13 93	14 40

The sample in I was different from that in II and evidently not so pure.

FERRIC CAMPHORATE. A strong solution of ferric chloride was precipitated with potassium camphorate, a bulky yellowish precipitate was formed, quite insoluble in water and hence easily washed. This gave on drying at 100° a buff-yellow powder. An analysis of this powder gave the percentage of iron as 19.34. The calculated percentage for $Fe_3 (C_{10} H_{14} O_4)_3$ is 15.86. This powder was then probably a subcamphorate. It was treated once more with a moderately strong solution of ferric chloride and again thoroughly washed. Analysis of this gave p.c. Fe = 18.84 and 18.90.

MERCURIC CAMPHORATE. A white heavy precipitate is formd in a concentrated solution of mercuric chloride on adding potassium camphorate. This was washed thoroughly and dried at 100°c. It forms a heavy white powder.

Analysis.

I. .4400 gramme of substance yielded .2150 grammes Hg.
II. .3840 " " " " .1920 " "

Hg.	calculated 50.25	found in I. 48 86	in II· 50.00

$C_{10} H_{14} O_4$

Chem. Laboratory, U. N. C.

DECOMPOSITION OF POTASSIUM CYANIDE.

I. H. MANNING.

Under the head of "Condensation of hydrocyanic acid" (Berichteder, d. chem. Ges. 18,1875) von der Pfordten discusses the discoloration produced in solutions of potassium cyanide by the addition of free acids, or of certain salts, or by simple heating the cyanide alone. This phenomenon was examined and studied to a certain extent by Mr. Wilkes in the first number of our journal (p. 19.) Herr von der Pfordten speaks of the decomposition of the cyanide on heating some hours in a test-tube placed in a water bath, as being due "probably to the long continued action of the carbon dioxide of the air." That this could not be the case was shown by Mr. Wilkes, who proved that the decomposition took place in the cold with all carbon dioxide carefully excluded.

The following experiment were undertaken to test the conclusion of Mr. Wilkes:

1. A saturated or nearly saturated solution of pure potassium cyanide was placed in a tube which was then sealed. Only a very nimute amount of carbon dioxide could have been present, yet the various changes of color were observed and after some weeks the liquid had become black and a blackish deposit had formed.

2. A similarly prepared tube was placed in boiling water; within five minutes a change to brownish-red was noticed, and the color rapidly darkened with the exposure.

3. A similarly prepared tube was fitted with cork and tubes, and while it was in the boiling water carbon dioxide was introduced. The changes were noticed very much as in experiment 2; apparently they were slightly delayed rather than hastened.

4. Into a tube prepared as in 3, hydrogen was passed in a rapid continuous stream. The changes were greatly delayed and no very deep discoloration was obtained.

5. If experiment 3 is so reversed that the carban dioxide is passed above a cold solution of the cyanide, giving opportunity for its absorption, the change of color is rapid and deep.

From these experiments the conclusion can be drawn that though carbon dioxide hastens the decomposition of the cyanide, as any free acid would do, yet it is not essential for this decomposition.

Chem. Laboratory, U. N. C.

LEAD CHLOR-SULPHO-CYANIDE.

R. G. GRISSOM.

This new compound of lead can be easily prepared by acting on lead chloride with a strong solution of potassium sulpho-cyanide. Freshly precipitated and recrystallized lead chloride was covered with a solution of potassium sulpho-cyanide in excess, and allowed to stand for several days. The liquid was then poured off and the residue treated several times with boiling water until all was dissolved. This fractional solution was carried out to separate, if possible, substances of different solubility. The fractions rapidly deposited crops of crystals on cooling, but examination under the microscope showed that these crystals were identical in crystalline form.

Analyses were made as follows:

.6220 gram. of substance gave .5730 gram $PbSO_4$, or 68.57 per ct Pb
1.0280 " " " " .7047 " " or 68.55 " " "

For chlorine and sulphocyanic acid 1.0700 grammes of the substance was dissolved in water and precipitated with silver nitrate. This was filtered and treated with strong nitric acid thus oxidizing the sulpho-cyanide. After dilution it was again filtered. The silver chloride was burned and the sulphuric acid determined in the filtrate in the usual way.

1.0700 grams. of substance yielded .1321 grams. of AgCe or 12.34 per ct. Cl and .8440 grams Ba SO_4 or 19 62 per ct CNS

	calc.	found	
Pb_2	68 46	68 57	68.55
Cl_2	11 91	12 34	
$(CNS)_2$	19.41	19.63	

The formula for the compound then is $PbCl_2$. $Pb(CNS)_2$. There is no water of crystallization and the substance can be heated to 150° without decomposition.

The solution poured off from the original lead chlor-sulpho-cyanide yielded mainly crystals of potassium chloride, together with some unchanged potassium sulpho-cyanide. The potassium sulpho-cyanide used was freshly prepared and purified by frequent recrystallization.

It is proposed to pursue farther the study of these double compounds of lead in the laboratory here.

Chem. Laboratory, U. N. C.

SOLUBILITY OF ALUMINA IN SULPHURIC ACID.

R. G. GRISSOM.

Ordinary commercial alumina is not very easily acted on by sulphuric acid, and this solubility varies very decidedly with the strength of the acid. The following experiments were undertaken to determine at what concentration the acid has the most powerful solvent action.

The sulphuric acid used contained 95.25 per ct. H_2SO_4. Ten grams of alumina were put in a 200 c. c. flask, and the mixture of sulphuric acid and water (cold) poured upon it. A series of such flasks were heated to 30° for one hour. The contents were then largely diluted and filtered as rapidly as possible into 1000 c. c. flasks. The alumina was then determined in duplicate, using 25 c. c. for each determination.

No.	C. C. H_2SO_4	C. C. H_2O	Ratio H_2SO_4 to H_2O	Dissolved Al_2O_3 30° c	Dissolved Al_2O_3 100° c.
1	5.4	0	20:1	1.6100	3.9300
2	5.4	1	4:1	1.2400	
3	5.4	2.3	2:1	1.6000	
4	5.4	4.9	1:1	2.7600	5.2800
5	5.4	10.0	1:2	3.1200	
6	5 4	15.1	1:3	3.1800	5.8400
7	5.4	20.3	1:4	3.2000	
8	5.4	25.4	1:5	3.2400	6.0600
9	10 8	61.1	1:6	3.5200	
10	10.8	81.7	1:8	3.2400	
11	10.8	102.3	1:10	2.6900	5.5200

In the last column Nos. 1, 4, 6, 8 and 11, only were repeated and in the first four cases 10.8 c. c. acid were used, as this amount suited better the weight of alumina taken and the size of the flask. These experiments of course do not determined the absolute solubility of alumina in sulphuric acid. The temperature and length of exposure are both factors in the solution. They serve to show soley to what extent it is advisable to dilute the acid in order to bring about the greatest solvent action. The best ratio of dilution seems to be 1:5 or 1:6.

Chem. Laboratory, U. N. C.

ANALYSIS OF WATER FROM THE ARTESIAN WELL AT DURHAM, N. C.

As this is the only deep artesian well in this State, it seemed of interest to have an analysis of the mineral matter held in solution by its water. A carefully drawn sample of this water was therefore analized. The sample was drawn during the summer of 1885, about five gallons being sealed in a new and clean demijohn and sent to this laboratory, under the direction of Mr. J. S. Carr.

The analysis resulted as follows:

In one kilogram of the water,		
K_2O	.00817	grammes.
Na_2O	.02352	"
Ca O	.06160	"
Mg O	.01717	"
Fe O	.02400	"
SO_3	.00446	"
Cl	.03412	"
SiO_2	.06200	"
Total solids	.2240	"

Or expressed in grains per gallons.	
Potassium chloride	29 grains.
Sodium chloride	3.84
Sodium sulphate	.42
Ferrous bicarbonate,	31
Calcium bicarbonate	11.43
Magnesium bicarbonate	3.65
Total solids by evaporation,	18.86

This well is drilled through the older Mesozoic rocks. According to Mr. O. R. Smith, who had charge of the work, the drilling was stopped at 1,650 feet without reaching overflowing water. The cutting was mainly through sandstone, and at different depths brine and traces of oil and gas were

struck. A sixty pound charge of dynamite was exploded in the hope of increasing the supply of water and by this the well was blocked up to within 528 feet of the surface. Attempts at drilling through these obstructions failed, and the explosion of an additional ten pound charge of dynamite brought about no good results. An iron casing was therefore let down to this depth, and the water analized was pumped from the 528 feet well.

F. P. VENABLE.

Chem. Laboratory, U. N. C.

THE FERTILIZER TRADE IN NORTH CAROLINA IN 1886.

W. B. PHILLIPS.

About 100,000 tons of Commercial Fertilizers are used in North Carolina annually, sold by 58 companies under 90 brands. Each brand pays an annual license tax of $500.00. Since the establishment of the Agric. Dept. in 1877, and the inauguration of the fertilizer control by the Agric. Expt. and Fert. Control Station, the number of brands and consumption of Commercial Fertilizers has shown a marked increase.

Brands of Fertilizers entered and amounts consumed from 1879 to 1886, inclusive:

	Brands.	Consumption. short tons.
1879.	42	60,000
1880.	48	80,000
1881.	58	85,000
1882.	86	92,000
1883.	92	95,000
1884.	80	95,000
1885.	83	95,000—100,000
1886.	90	95,000—100,000

Each brand is subject to analysis at the Expt. Station, and the figures allowed for available Phosphoric Acid.

(Soluble and Reverted.) Ammonia and Potash at the sea-board are as follows:

	Cents per pound.
Available Phosphoric Acid,	7½
Ammonia,	16
Potash, (K_2O)	5

Accepting these figures agreed upon by the State Chemists of North and South Carolina, Georgia and Alabama,

the following table will show the commercial valuation of the *ammoniated super-phosphates with potash* ("complete fertilizer") from 1880 to 1886, inclusive, as given in the 1886 report of the N. C. Expt. Station, page 21.

	1880 per ct	1882 per ct.	1883 per ct.	1884 per ct.	1885 per ct.	1886 per ct.
Available Phos. Acid	7.40	8.91	8 59	8.15	9.13	8 96
Ammonia	2.70	2 60	2 33	2.67	2 65	2.53
Potash	1 30	1.82	.218	2.13	2 34	2.30
Valuation on 1886 basis	$21.04	$23 51	$22.53	$22 90	$24 52	$23.44

The following table will show where the brands used in North Carolina are manufactured, (Rep. N. C. Expt Station, 1886, p. 21).

	1880	1881	1882	1883	1884	1885	1886
Massachusetts	2	3	—	2	2	3	1
Connecticut	1	2	2	4	3	3	1
New York	3	6	5	3	2	4	3
New Jersey	3	3	1	1	1	2	8
Delaware	2	2	2	2	2	4	4
Maryland	21	25	45	42	30	31	35
Pennsylvania	—	—	1	1	—	—	1
Virginia	7	9	15	17	20	18	21
North Carolina	3	3	6	6	3	9	10
South Carolina	5	6	9	14	12	11	11
Total	57	59	86	92	80	85	90

The following table shows the amounts of Kainit, Guano, Phosphate and Phosphate Rock received at the Port of Wilmington, N. C., from January 1st to December 31st, of each year.

Year.	Imported from	Kainit.		Guano.		Phosphate.		Phosphate Rock.	
		Tons	Value	Tons	Value	Tons	Value	Tons	Value
1877	Germany...	1,200	$10,548		$		$		$
1878	Germany...	300	2,098						
1879	Germany...	1,257	9,262						
1880	Germany...	3,068	14,894						
1880	Nova Scotia							600	615
1881	Germany...	3,334	23,696					Rock	564
1882	Germany..	6,867	43,219					Plaster	
1882	England....			325	18,414	400	7,283	500	
1883	Germany...	8,220	54,619						
1884	Germany.	13,348	82,503						
1884	England....					950	23,809		
1885	Germany...	9,084	62,851						
1885	England..			980	10,760	1,200	15,113		
1886	England.,..			76	2,493	745	8,752		
1886	France.....			855	48,178				
1886	Germany...	13,042	91,776						
	Total	59720	$395566	2236	$81844	3295	$54957	600	$615
								Rock	
								Plaster 550	$564

In addition there is brought into Wilmington from outside the United States, about 5,000 tons of Navassa Phosphate Rock annually, costing, f. o. b., about $7.00, from the Navassa Island, West Indies, all of which is consumed by the Navassa Guano Company of Wilmington. One cargo of 500 tons Roncador Island Phosphate Rock was brought into Wilmington in February 1885, but the venture was not successful, and no more has been brought.

Production of Fertilizers in North Carolina in 1886.

Company.	Location.	Product		
		Guano short tons	A'd Phosphate short tons.	Gr'd Rock short tons
Navassa Guano.. ..	Wilmington,.....	6000	10000	
Acme Manufacturing	Wilmington – Cronly	2152		
Goldsboro Oil.....	Goldsboro	2250		
N. C. Phosphate	Raleigh.....			est'd 500
French Bro.'s ..	Rocky Point.....			900
Enterprise Fertilizer	Tarboro, estimated..	1000		
Durham Fertilizer..		1000		
Total.....		12402	10000	1403

The value of these products can not be stated exactly, but will be very nearly given by the following figures:

Value of fertilizers produced in North Carolina in 1886.

12,402 tons	Guano -	$23.00	$285,246
10,000 tons	Acid Phosphate	14.00	140,000
1,400 tons	Ground Rock	9.00	12,600
23,802 "	Fertilizers valued at -		$437,846

It must, however be noted here that some of the companies buy acid Phosphate of North Carolina make, mix it with cotton-seed meal or other ammoniate and sell it as Guano. It is difficult to say exactly how much acid phosphate is thus counted twice, first as acid phosphate, the company selling it as such, and then by the purchaser as Guano after it has been dry mixed with some ammoniate. But there is reason for believing that this would not exceed 1,500 tons of the acid phosphate, corresponding to about 2,500 tons guano. A fair allowance would be 1,500 tons to be subtracted from the guano out-put. The preceding table would then stand corrected as follows:

12,402 tons Guano less 1,500 tons—		
10,902 tons Guano at -	$23.00	$250,746
10,000 tons Acid Phosphate at	14.00	140,000
1,400 tons Ground Rock at	9.00	12,000
22,000 tons fertilizers valued at		$403,346

The 1,400 tons Ground Rock is not counted twice as it is North Carolina Phosphate Rock, Phosphate Conglomerate, etc., raised in the State, and sold as "fine ground" without being acidulated or ammoniated.

By reference to the table of production it will be seen that two companies make a speciality of "fine ground" Rock, French Bros at Rocky Point, Pender county, and the North Carolina Phosphate Company at Raleigh.

French Bros. have been in the business for several years, mining and grinding their own rock from contiguous deposits. The rock is a phosphatic conglomerate, a mass of phosphatic pebbles and nodules in a cement of carbonate of lime. It is burnt in kilns, screened, and the residue ground. This residue may contain:

Phosphate of Lime - - 20.34 per cent.
Lime, as oxide and hydrate 37.52 per cent.

(For further information as to this see under "General Observations.")

Owing to insufficient machinery this company has not been able to place as much of their product on the market as they expect to do before long. The ground rock has a good reputation as a fertilizer.

The North Carolina Phosphate Company at Raleigh uses this rock also, obtaining it from Castle Hayne near Rocky Point. They have a very complete mill, with a Foster crusher, and two Frisbee-Lucop grinders, and are doing an increasing business, with a daily capacity of thirty tons.

Besides these two companies there are none that use North Carolina rock.

NAVASSA GUANO CO., WILMINGTON, N. C;

works at Meares Bluff, Cape Fear river, five miles above Wilmington, established in 1869, and do the largest business of any company manufacturing in North Carolina. They use 11,000 tons of crude rock per annum, of which 5,000 tons is Navassa and 6,000 tons South Carolina Rock. Their daily capacity is

Ground Rock - - -	33 tons
Acid Phosphate - - -	70 tons
Guano - - - -	75 tons
Total	178 tons.

Of their total production of 16,000 tons, they sell in North Carolina 10,000 tons. They make their own acid from Sicily Sulphur, and are well equipped and well situated.

ACME MANUFACTURING CO., WILMINGTON, N. C.

works at Cronly, on Carolina Central Railway, 17 miles from Wilmington. The year ending December 1, 1886, is really their first year in the business, as they were experimenting and getting ready. They use South Carolina rock, and have a daily capacity of

Ground Rock, - -	15 tons.
Acid Phosphate - -	30 tons.
Guano - - -	60 tons.
Total	105 tons.

They make their own acid from Sicily Sulpher, and are well equipped, though not very well situated, They sell nearly all their product in North Carolina.

The Goldsboro Oil Co., the Enterprise Fertilizer Co.,

(Tarboro), and the Durham Fertilizer Co., buy Acid Phosphate, and 'dry-mix' their own Guano.

THE PRESENT OUTLOOK IN NORTH CAROLINA.

Opinions vary. Some think the prospect fair, others are inclined to take rather despondent views.

Fertilizers have declined in price, and the $500 tax is not popular. There has been little or no mining of the regular North Carolina Phosphate Rock (containing 20-22 per cent. Phosphoric acid), for the reason that it lies in 'pockets' somewhat widely separated, and the topography of the region is unfavorable for cheap mining. As long as Charleston, S. C. Rock guaranteed to run 55 per cent. Bone Phosphate (25,19 per cent. Phosphoric acid) can be bought f. o. b. for $5.50 to $6.50, there is but little prospect of the North Carolina Rock coming into market in any quantity.

The first systematic investigation of this Rock was made by W. B. Phillips in September, 1883, at the request of the Navassa Guano Company. In his report to that company, published in pamphlet form ("North Carolina Phosphates October, 1883") he took the ground that the steepness of the slopes on the sides of most of the little streams where the rock occurs would necessitate an excessive amount of digging, with proportional increase of expense, which the low grade of the rock would not repay. In march 1884, appeared the Report of the Experiment Station on North Carolina Phosphates, and since that time numerous references have been made to the matter in the publications of the Station, and of the Agricultural Department.

While the rock makes an excellent quality of acid Phosphate it remains to be seen whether it can compete with Charleston Rock. So far it has not competed, for the reason that none of it has been offered. As to how soon, if at all, it will be offered,is a very obscure question, and one which time, and it may be a good deal of it, alone can answer. As to the other raw materials for the manufacture of fertilizers, viz: *fish-scrap* and *cotton seed meal* as nitrogenous matter, *pyrites* as source of sulphuric acid, and *bones*, the following may be said:

FISH, OIL, AND SCRAP MILLS.

There are seven (7) in the State, three (3) of fair capacity, and four (4) small. Employment is given from April to November, to about 400 men, and the yearly value of the oil and scrap is about $150,000.

The amount of North Carolina fish-scrap bought by the Navassa Guano Company in two yenrs, ending February 5, 1885, was about 3,500 bags (140 tons), and they buy most of the scrap made in the State. This will give 1,700 bags (75 tons) per annum, which is perhaps rather less than the real production. The true figures will fall not far short of 100 tons. Good scrap should yield 10 per cent. ammonia on 10 per cent. water. The account will stand.

One hundred tons fish scrap 10 per cent., a $2.50 per unit, $2500. About one-third (⅓) of this is made at the mouth of the Cape Fear River, and the other two-thirds on Pamlico Sound, around Beaufort. The industry might be greatly enlarged, as there is always a good market for the scrap.

COTTON SEED OIL MILLS

There are nine in the State, with a total capacity in seed of 200 tons daily. A ton (2000 lbs.) of seed should yield 800 pounds of cake. The cake is worth $2.50 per unit of Ammonia, and should run 8.5 per cent.

It is not know what proportion of the cake made goes into fertilizers, probably not above 4,000 tons. The product of two average size mills (the Acme and Goldsboro) is almost entirely used in this way.

PYRITES.

None mined for sulphuric acid. All the acid used in the manufacture of the fertilizers is made from Sicily Sulphur.

BONES.

Bones are collected, but only in a small way. There is at Salem a small mill for grinding bones, and the Navassa Guano Company buys them from local dealers in small lots. The total quantity is hardly above 100 tons per annum, and so we have 100 tons Bones a $10, $1,000.

MARL.

The use of marl is local, and confined almost entirely to the Eastern part of the State. Very little, if any, is shipped by rail, each neighborhood using what is convenient, and easily transported by wagons. This is to be regretted, as the heavy clay soils of the middle part of the State would respond very readily to such an applicatiou.

GENERAL OBSERVATIONS.

The most marked feature of the fertilizer trade in North Carolina in 1886, was the increased demand for fine ground

phosphate rock. The new mill at Raleigh was built to supply this demand, and the steady growth of the sales is an indication of the esteem in which the product is held.

An analysis of the article made at the Experiment Station is as follows:

Analysis of Ground North Carolina Phosphate Rock:

[1] Bone Phosphate	11.16 per cent.
Carbonate of Lime	64.26 per cent.
Magnesia	0.81 per cent.
Potash	0.40 per cent.
Water	1.39 per cent.

The fine ground rock offered by French Bros. is of a somewhat higher grade. An analysis of their best grade is as follows:

[2] Phosphate of Lime	20.34 per cent
Carbonate of Lime	——
Lime as Oxide and Hydrate	37.52 per cent
Oxides of Iron and aluminum, and loss	5.65 per cent

This analysis represents the composition of the residue from burning and screening.

The composition before burning and screening is as follows:

[3] Phosphate of Lime	16.42 per cent.
Carbonate of Lime	54.71 per cent.
Lime as oxide and hydrate	——
Oxides of Iron and Aluminum, and loss	3.91 per cent.

The burning and screening separates the phosphatic nodules from the cement of carbonate of lime and converts this last into lime oxide and hydrate. All three of these articles are growing in favor with the farmers. The utilization of raw ground rock in the preparation of home-made manures, is one of the reasons why the price of acid phosphate and guano has declined. Extra inducements in the shape of lower prices have now to be offered since the farmer has discovered that he can buy a good article for nearly 50 per cent. less than he has been accustomed to pay.

[1] Equivalent to Phosphoric acid 6.11 per cent.
[2] Equivalent to Phosphoric acid 9.31 per cent.
[3] Equivalent to Phosphoric acid 7.52 per cent.

Total value of all fertilizing materials made in North Carolina in 1886.

10,902 tons Guano at	$23.00 - -	$250,746
10,000 tons acid phosphate at	14.00 - -	140,000
1,400 tons Ground Rock at	9.00 - -	12,600
100 tons Fish Scrap at	25.00 - -	2,500
4,000 tons Cotton Seed Meal at	22.00 - -	8,800
100 tons Bones at	10.00 - -	1,000
Total value		$494,846

W. B. PHILLIPS.

LIST OF EXCHANGES.

GERMANY.

Der Naturhistorishe Verein in Bonn.
Der Naturwissenschaftliche Verein in Magdeburg.
Der Naturwissenschaftliche Verein in Bremen.
Berliner Entomologischer Verein.
Die Naturforschende Gesellschaft in Danzig.
Der Naturwissenschaftliche Verein in Regensburg.
Der Naturhistorische Verein in Augsburg.
Die Senckenbergische Naturforschende Gesellschaft in Frankfurt.

SWITZERLAND.

Die Naturforschende Gesellschaft in Bern.
La Societe Fribourgeoise des Sciences Naturelles Fribourg

FRANCE.

La Societe Linneenne, de Normandie.
La Societe Linneenne, du Nord de la France, Amiens.

ITALY.

Societe Toscana di Scienze Naturali in Pisa.
Regio Istituto Veneto di Scienze Letture ed Arti, Venice

RUSSIA.

La Societe Imperiale des Naturalistes, de Moscou.
La Societe des Naturalistes de la Nouvelle Russie, Odessa.

MEXICO.

Sociedad Mexicana de Historia Natural.

GREAT BRITAIN AND IRELAND.

Yorkshire Geological and Polytechnic Society, Halifax England.
Dumfriesshire and Galloway Natural History Society Dumfries, Scotland.
Belfast Naturalists-Field Club, Belfast, Ireland.

CANADA.

Royal Society of Canada, Ottawa.
Ottawa Field Naturalist's Club.
Canadian Institute, Toronto.
Nova Scotian Institute of Natural Science, Halifax.
Natural History Society, Montreal.
Connecticut Academy of Arts and Sciences, New Haven.
Academy of Natural Sciences, Davenport.
Kansas Academy of Sciences, Manhattan.
National Academy of Sciences, Washington.
Peabody Academy of Science, Salem.
Society of Natural History, Brookville.
Natural Science Association of Staten Island.
Science Association, Peoria.
Scientific Association, Meriden,
Natural History Society, Trenton.
Linnean Society, New York.
Academy of Science, St. Louis.
Washington Chemical Soceity.
Michigan Horticultural Society.
Illinois State Laboratory of Natural History.
Wagner Free Institute of Science, Philadelphia.
American Academy of Arts and Science.
Western American Scientist.
Leander McCormick Observatory, University of Virginia.
Smithsonian Institution, Washington.
Washburn College Laboratory of Natural History, Kansas.
United States Geological Survey
Johns Hopkins University.—Circulars.
Cornell University.—Bulletins.
University of California.—Agricultural Reports
Modern Language Notes.—Baltimore.
Boston Public Library.—Bulletins.
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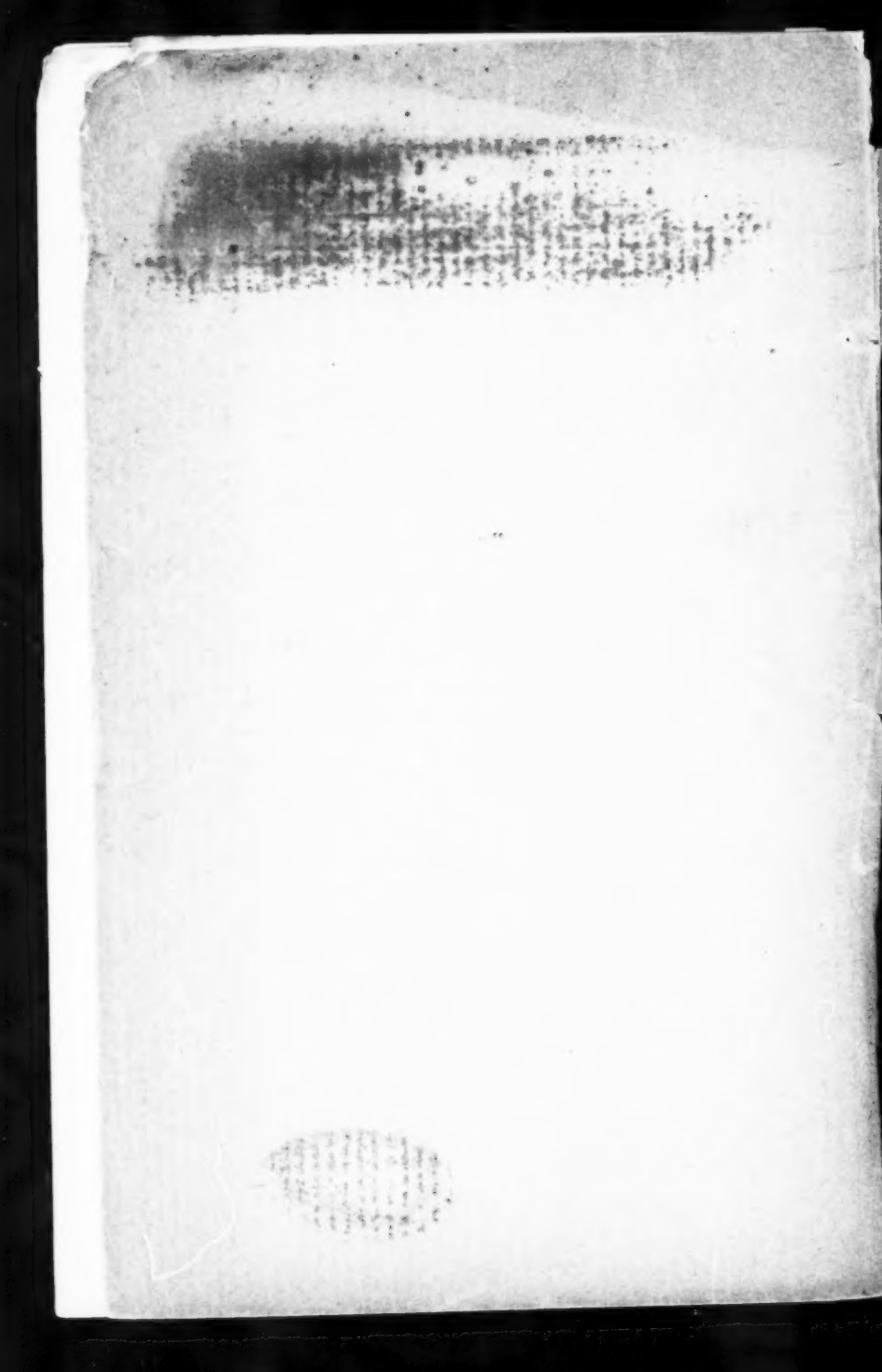
N. C. Department of Agriculture.—Bulletins.

UNITED STATES.

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